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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XI. No. 128. AUGUST, 1930. PRICE 1s. NET

STATUE DISCOVERED AT UR

(See page 255)

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DISCOVERY

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Editorial Notes.

About a year ago we noted in these columns that Sir Hubert Wilkins was planning to explore the North Pole in a submarine. Nothing more had been heard of the project until last month, when it was confirmed by the explorer himself in an interview with the London *News-Chronicle*. According to this latest information, the expedition will be made in an American submarine, and its estimated cost is £100,000. Sir Hubert expects to set out next May, and will make Spitzbergen the starting-point of a voyage across the Pole to Alaska. The distance to be travelled is about two thousand miles, which should take fifty days to accomplish in the submarine. "Whenever we find that the ice blocks our course," Sir Hubert stated, "we will simply submerge and trick Nature that way." He estimates that the average thickness of the ice will be about ten feet, but it will probably be necessary to submerge to a depth of twenty-five feet. The submarine has been constructed for remaining below the ice for two and one half days at a time. It is 375 feet long, weighs 350 tons, and is propelled by an engine of 500 horse-power. The speed is fourteen knots on the surface and nine knots submerged, but it is expected that less than four miles per hour will be the average rate of progress under the ice. The scientists and crew will number eighteen altogether. The party will be international in character, and is to include British, Americans, Germans and Dutchmen. The leader of the expedition does not anticipate that food supplies will present any difficulty. One of his objects, in fact, is to show that a submarine can land provisions at the Pole, thus advancing greatly the possibility of maintaining a depot all the year round. Sir Hubert's plans include the making of a continuous talking-film record of his journey. He also intends to broadcast accounts of the submarine's progress. This would naturally be carried out from the surface and, as he told his interviewer, it should be a thrilling moment when he concludes the daily message—"*Au revoir*, everybody. We are now submerging."

* * * * *

The discoveries in Mesopotamia since the war have been so brilliant and numerous that fresh finds are now taken almost for granted. The widespread interest aroused in Ur of the Chaldees is mainly due to Mr. Leonard Woolley, whose skill in explaining its story to the public is only equalled by his ability as an excavator. As a measure of his success it may, indeed, be admitted that some of his readers are by now inclined to tire of the graves and their rich contents. For this reason the latest discoveries are specially welcome, as they throw the whole picture into perspective. The early chapters of *Genesis* have always fired the imagination, and now for the first time is revealed the historical basis of much that was thought to be legendary. The new evidence of the Flood discovered last autumn, was followed by remarkable facts about the canal system of Ur, which make it clear that this ancient city on the Euphrates was not unlike the Venice of to-day. To preserve the buildings from the river waters and constant floods, a massive wall was erected, with which were associated some of the most beautiful buildings yet unearthed in Mesopotamia. These and other features of the season's work are reviewed on another page by Mr. M. E. L. Mallowan.

* * * * *

The latest report of the British Empire Cancer Campaign contains much evidence of the progress

*

that is being made in fighting this disease. The system of correlating the results of research has been improved, so as to avoid overlapping, and it is now possible for workers in one institution to profit by the discoveries in another with the least amount of delay. Progress in actual research includes the discovery that "mustard gas"—the poison which wrought such havoc during the war—possesses powers of preventing the onset of cancer in areas of the skin to which cancer-producing tars have been applied. This work was undertaken at the University of Leeds. It is, of course, well known that certain tars may cause cancer, and the increased use of these substances in modern conditions is thought by some experts to be a possible explanation for the spread of the disease. The action of the mustard gas is localized to the particular area and is strictly limited in time, but is none the less on that account a remarkable one. The mustard gas does not prevent the active growth of skin which follows the application of tar and precedes the formation of cancer. It seems, therefore, to be the first true anti-carcinagenic agent ever discovered.

* * * * *

A new record in deep-sea diving has been accomplished in Bermuda waters by Dr. William Beebe, the well-known American naturalist. "Battened down" in a steel sphere of approximately five feet internal diameter he descended with another explorer, Mr. Otis Barton, to a depth of 1,426 feet. The apparatus contained oxygen tanks, with chemicals for absorbing the breathed air, and was lowered by cable from a ship. A telephone wire maintained connexion with the crew above, and the explorers described what they observed from the sphere. According to *The Times*, Dr. Beebe found that at 1,400 feet most of the light from the sun had been cut off by the intervening water, only the rays at the blue-violet end of the spectrum penetrating to this depth. He was, nevertheless, able to observe the fishes that swam past the windows of the sphere. Most of them belonged to the class which carry their own lighting systems—showing a great variety of structure but all depending, apparently, on luciferin and luciferase, two chemicals of which little is so far known.

* * * * *

The practice of issuing books with titles that do not describe their contents was criticized recently by one of our reviewers. The other extreme is, of course, often met with in the case of scientific subjects, when a readable story is obscured by the forbidding description on the cover. A happy combination has been chosen by Mr. Sidney de la Rue for his book, "The Land of the Pepper Bird: Liberia" (Harrap), which gives a picture of that remarkable black republic on the west coast of Africa. Very little has hitherto been written about Liberia, and the author is well qualified to do so, having spent several years there in the official capacity of Financial Adviser. Apart from its growing importance in world trade, the country affords an interesting study in native government and politics. Mr. de la Rue describes the customs of the people and their economic problems, and devotes several interesting chapters to native cults and the dread Black Magic.

* * * * *

It is now possible to see London from the air while taking a cup of afternoon tea. On Fridays, Saturdays and Sundays throughout the summer, Imperial Airways are providing this novel entertainment, which occupies only two hours and costs two guineas. Passengers for these "tea flights" leave Airways House, Charles Street, at 2.30 p.m., and drive by car to Croydon aerodrome, where a Silver Wing air liner awaits them. During the next half hour they cruise over London, and while tea is served they are afforded an entirely new impression of the world's greatest city. Those who have not flown before will probably be most impressed by the extraordinary "neatness" of everything, as one by one the familiar landmarks appear in miniature below. Bad sailors need not be deterred by air sickness—we write from experience—as in the short space of half an hour there is not time to become affected by dizziness, which sometimes makes long distance flying so intolerable.

* * * * *

The articles in our British Association Number next month will be closely related to the Bristol proceedings. There will be a biographical sketch and portrait of the President, Professor F. O. Bower; some advance notes on the meeting referring to the principal subjects for discussion; and a valuable review of the Association's activities since the war, written specially for *Discovery* by the Secretary, Mr. O. J. R. Howarth. The period has been notable as including among its presidents the Prince of Wales, and there have been two overseas meetings since 1920, in Toronto and in Cape Town. Readers visiting Bristol will be interested to hear that another contributor is to discuss the scientific aspects of the tobacco industry, which is so closely associated with the city. Lastly, the Vice-Chancellor, Dr. Thomas Loveday, will describe the University of Bristol, so resuming the series of articles on British universities that was commenced in the spring The Centenary of the Association will be celebrated in London next year.

How Pluto was Discovered.

By Henry Norris Russell, Ph.D.

Director of the Observatory at Princeton University, U.S.A.

The recent discovery of a new planet has been followed by much controversy on the true nature of the object. In the opinion of our contributor, there can be no doubt that it is actually a major planet, much farther away than any previously known. The name Pluto has just been assigned to it by American astronomers.

THE widespread and justified sensation caused by the discovery of the new major planet of our solar system will have passed long before these words appear in print. But the discovery itself is so important and illustrates so well the methods of modern astronomy that it should not fail to be set out in order here.

Everyone knows how Neptune, the last great planet to be discovered, was found. After Uranus had been known for half a century or more it was found to deviate from the orbit determined from the first fifty years of observations, after full allowance had been made for the attraction of the then known planets. Some unknown body must be pulling at it, and this could only be a planet still farther from the sun. To calculate from the observed perturbations of Uranus' motion the orbit of the unknown planet which produced them was a very intricate matter. But the problem was solved by Le Verrier in France and Adams in England, and the planet Neptune was found within a degree or so of the place in the heavens which these calculations pointed out.

Through all the eighty-four years since the discovery of Neptune, the possibility that there was a still remoter planet has been realized, and now that Pluto has been discovered the layman natural may ask, " Why, if it was there all the time, did not the mathematicians tell us where to find it? " As a matter of fact they did, but through no fault of theirs their answer could not be as precise as it was for the earlier problem of Neptune.

A Difficult Task.

To calculate the perturbations produced in the motion of one planet by the attraction of another is no small task, even when the orbits of both are accurately known in advance ; and to work backward from the perturbations of a known planet to the orbit of an unknown one is much harder. But mathematical astronomers are used to hard problems and know how to solve this one. The worst difficulty is that to find the perturbations we must compare the observed positions of the known planet with those which it *would have had* if the unknown planet had not been attracted. To determine the latter is evidently difficult.

To see how it can be done let us ignore the attractions of the known planets (or suppose that, as in practice, their effects have been calculated and allowed for). We then know that, barring unknown influences, the planet should move in an exact ellipse about the sun in accordance with Kepler's familiar laws. What the size and shape of this ellipse may be can be found only by observing the planet. If no extraneous forces are acting, the planet will follow the same ellipse time after time, but if an unknown planet is perturbing it the tracks in the second and subsequent revolution will not be quite the same, and the differences will reveal the amount and nature of the perturbations.

Prediction Methods.

It is not actually necessary to wait quite so long. When a planet has been well observed half around its orbit, its motion along the other half can be predicted closely enough to reveal any considerable disturbances after it has been followed in this half as well. But something like a full revolution around the sun is really necessary. With observations covering only half the orbit or less, it is possible to find a " fictitious orbit " such that a planet moving in it without perturbations (save by the attractions of known bodies) will, *over the given interval of time*, always be very near the real planet—subject though it is to additional perturbations, and though in earlier or later years this will not be true.

It may help to understand this to imagine a circular hoop which has been bent and battered a little out of shape (see page 253). If we can see the whole hoop or half a photograph of it it is easy enough to strike a true circle which follows its general course, and then find the amount of the deformations from point to point. But if our photograph covers but a small part of the hoop and we try to fit a circle to it as best we can, we may draw it too large or too small, according as this particular part of the hoop has been flattened or bent too sharply.

The heavy line in the diagram represents a battered hoop which in a rough way illustrates a perturbed orbit. The circle represents the hoop before it was deformed, or the unperturbed orbit. But if we knew only the part AB of the hoop we would suppose that the whole was like the dotted circle and would greatly under-estimate the amount, and sometimes even the direction, in which this portion had been bent out of shape. In quite the same way we cannot get any accurate idea of the perturbations of a planet unless we have observations extending pretty well around the orbit.

Now since its discovery in 1846 Neptune has been only halfway around its orbit, and it is therefore practically valueless for locating an outer planet by means of its perturbations. Uranus has completed two revolutions since its discovery and is fully available, but it is nearer the sun and farther from the trans-Neptunian planet and the perturbations to be anticipated are therefore small.

Preliminary Problems.

Several investigators have examined the question, the most comprehensive work being probably that of the late Dr. Percival Lowell, which was published in 1914 but commenced more than a decade earlier. A careful mathematical investigation indicated the existence of small perturbations just within the limit of detection, and indicated that the unknown planet which produced them must be either in the direction of the constellation Gemini or just on the opposite side of the sun. The perturbations produced by planets in these two positions were so much alike that no decisive choice between the two could be made.

Lowell estimated the new planet's distance from the sun as 43 to 44.7 astronomical units—half as much again as Neptune's—and its mass as 1/50,000th that of the sun, six times the earth's, but only one-third of that of Uranus or Neptune. Accepting these conclusions, the next question was how to find the planet. Being less massive than Neptune it was doubtless smaller, and being far from the sun it must be faintly illuminated and far from conspicuous. Lowell estimated its probable brightness as from the 12th to the 13th magnitude. It is hopeless to search for such an object visually among the multitudes of stars, and the only chance of success is by photography, employing substantially the same methods as have been proved so successful in finding asteroids; that is, the careful comparison of suitably duplicated plates of the same star fields.

A great deal of time and labour was thus spent by Dr. Lowell and his successors at the observatory which he founded at Flagstaff, Arizona, and which bears his name. In time it became clear that the distant planet was probably fainter than the original estimate, which in the nature of the case could only be very rough, and that a very powerful instrument would be required to find it. A gift from the President of Harvard, Percival Lowell's younger brother, provided an admirable instrument. It possesses a triple objective of thirteen inches aperture which gives sharp star images over a wide field, and is withal very rapid.

The new Lawrence Lowell telescope within a year of its installation has brought the long-sought planet to light. Photographs of moderate exposure covering the whole region of the heavens around the predicted position were obtained, and on one of them, taken on 21st January, 1930, Mr. Tombaugh of the observatory staff found "a very promising object." It was identified from its motion past the numerous fixed stars as revealed on plates of the same star field while being compared under the blink comparator. This showed that one faint star among many thousands had shifted its place by a certain expected order of distance, in the interval between the taking of the two plates. Since that date it has been carefully followed both photographically by Dr. Lampland with the 40-inch reflector, and visually by E. C. Slipher and other members of the staff. Its motion in the heavens has been just what might be expected of a trans-Neptunian planet at about the distance anticipated by Lowell, and its longitude agrees closely with his predictions. There is no doubt that it is actually a new major planet much farther away than any which has previously been known.

This admirable discovery comes to the astronomers at Flagstaff as a reward of years of skilful development of methods and patient work. It is most gratifying that this long and devoted search has been crowned with full success, though we must all regret that the originator and inspirer of the campaign did not live to witness its triumphant close.

Observing the Orbit.

What of the new planet itself? Full knowledge comparable to that which we have regarding the other planets of our system can come only after years of further work. For example, it will be a long time before its orbit is accurately known. A fairly good orbit of a rapidly moving asteroid can be derived from three good observations separated by intervals of a week or so. For this slowly moving body intervals of a couple of months will be desirable. Before it was lost in the light of the sun, which happened in May,

sufficient data to give a good preliminary orbit, which will tell us where to look for the planet at the end of summer when it can again be observed, was worked out and published (12th April). Next year's observations will permit a considerably better determination; and so on.

Even after a decade, however, we will have observations covering only a very small fraction of the orbit and will still be somewhat in the position of having to determine the course of a whole circle from a small arc. It may happen that, calculating backward, the images of the planet can be found on photographs taken years before it was discovered, though it is so faint that the chance is not very good. And in this case the arc available for determining the orbit, and the calculated results, may be increased. At this early date we can be certain only that the planet is near the ecliptic, that it is moving around the sun in the same direction as the other planets, and that the inclination of its orbit plane, while greater than the other planets, as Lowell predicted, is not extremely great. The general agreement of its apparent motion with that calculated with Lowell's estimated distance of 43 to 44.7 astronomical units shows, however, that this prediction is near the truth.

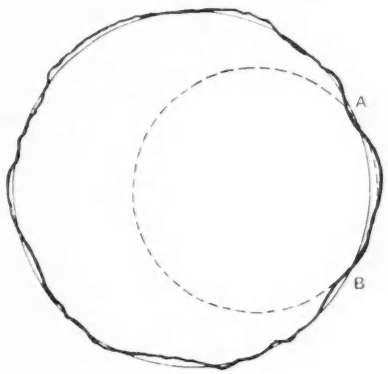


Diagram of the perturbed orbit of a planet, showing how when only a portion (AB) has been observed the true orbit may be greatly underestimated.

Adopting provisionally this distance, which is fifty per cent greater than Neptune's, what else can now be said about the planet? Its diameter must be rather small. With the 24-inch refractor at Flagstaff the planet appears as a faint stellar point and shows no sensible disc.

If it were really as much as 10,000 miles in diameter it would show an apparent disc of 0″.5, which the experienced observers who have examined it hardly could have missed under favourable conditions. We may conclude with some confidence therefore that the new planet is little if at all larger than our earth—provided, to be sure, that the estimate of its distance here adopted is correct.

Further evidence that the planet is a small one is found in its faintness. The assigned magnitude, about 15.5, is photographic. If it is of the average colour of the inner planets it should be about a magnitude brighter visually than photographically, and we may base our estimates on a visual magnitude of 14 or 14.7. This makes the planet only about 1/250th as bright, apparently, as Neptune. If Neptune could be removed to this greater distance it would look only one-fifth as bright as it does now, but even so it would outshine Pluto fifty-fold. This suggests that the diameter of the new planet is about one-seventh that of Neptune, or a little less than 3,000 miles. This estimate, however, may be too small, for Neptune has the highest superficial reflecting power, or albedo, of any of the planets, and a planet of lower albedo would have to be larger to reflect the same amount of light. To go to the opposite extreme we may take for comparison the moon, which has about the lowest known albedo. A simple calculation shows that if removed to a distance of 45 astronomical units from us and from the sun, she would appear as a star of visual magnitude 17. Now Pluto appears three magnitudes or sixteen times brighter, which on this hypothesis regarding its surface brightness makes its diameter four times that of the moon, or 8,600 miles. It is probable that the truth lies between these two estimates, but little more can be said, for there are very great differences of albedo even among the atmosphereless asteroids, and we have no means of estimating more closely what value we should use for the new planet. It may be considered, nevertheless, that it is fairly comparable in size with the four inner planets of our system, and much smaller than the four outer ones which were previously known.

The planet's mass can probably be determined at least roughly from the perturbations it produces in Uranus and Neptune when once its orbit is accurately known. The latter statement may seem inconsistent with what has already been said, but the problem here is not quite the same as before. Suppose that, in the diagram, we knew the direction in which the wavy line deviated from the circle at each point and the relative though not the absolute amounts of these deviations. We would then have much less latitude in drawing our theoretical circle than before, and could be fairly sure of its position in cases which before were hopeless, as already explained.

A planet less than 10,000 miles in diameter would be very unlikely to have a mass 1/50,000 that of our

sun, for this would demand a mean density about seventeen times that of water. The earth's mass is only 1/330,000th of the sun's, and if Pluto is no more massive it is hard to see how its attraction could produce the effects studied by Lowell. This discrepancy would be diminished if the planet's distance from the sun should turn out to be greater, but it is premature to discuss the matter further at present, without more dependable data.

The only hope of learning anything about the rotation of the new planet is by photometric means. If, like many of the asteroids, it should show regular periodic changes in brightness, these would reveal the rotation. But for so faint an object, the observations would be difficult. Finally, there is little hope of detecting a satellite of the planet unless, like our moon, it should be almost comparable in size with its primary. Nevertheless, it is probable that photographs will be made with the great reflectors, in order to investigate.

In conclusion, two tributes must be paid where honour is due: first, to the skill, assiduity, and devotion of the workers at the Lowell Observatory who have made this important discovery; and, second, to the memory of Percival Lowell, traveller, man of letters and affairs, and observer of the planets. He did many things in the course of a crowded life and did them well. The mathematical researches took him outside his other fields of work and into a region full of traps for the unwary, yet the discovery of this new planet has justified him by his works despite the doubts of many of his contemporaries. His fame bids fair to increase as the years pass on.

The Cinema Aids Astronomy.

An important advance in the technique of astronomy has resulted from the demands of the motion picture industry. It often happens that something discovered in the laboratory afterwards meets commercial requirements, but the reverse is not so common. A need arose for cinema films which would permit the taking of night scenes during the daytime, since great expense could thereby be saved. It has long been known to photographers that a plate exposed to the invisible part of the solar spectrum produces a picture that looks very much as though it had been taken at night. The sky, for example, comes out dark instead of light. But the method employed was unsuitable for commercial requirements. It was thus that experiments were made in the Kodak laboratories under the direction of Dr. Mees, which resulted in the discovery of dyes that would serve the required purpose. A report on the subject has just been issued by the Carnegie Institution of Washington.

The earliest method of photographing the "infra-red" rays was used by Sir William Abney nearly fifty years ago. His results were obtained with a special form of silver bromide which had the power of absorbing red and infra-red radiation; he used no dyes. He prepared his own photographic plates shortly before using them, employing an elaborate process which is troublesome and uncertain. It has never been seriously applied to modern spectroscopy, though the resources of the present chemical laboratory would perhaps warrant a revival of it.

Neocyanine.

The most important of the new dyes is called Neocyanine, and is produced in the form of beautiful red crystals which are soluble in alcohol. An ordinary photographic plate treated with this solution acquires infra-red sensitivity far beyond that obtainable with other chemicals. As applied to astronomy, the importance of this discovery is that the light from the sun can now be analysed much more accurately than has been possible hitherto. A filter is used on the spectrograph which stops the visible light and transmits the invisible rays. The plate is exposed to this for about seven hours, and then developed in total darkness. By means of this method hundreds of spectral lines emanating from atoms in the sun's atmosphere are now being accurately measured for the first time. As carbon is among the most abundant elements in the earth, we should expect it to be abundant in the sun also, since the best tests that can be made indicate that the sun affords a fair chemical sample of the material universe.

Hitherto the only evidence of the presence of atomic carbon in the sun was that indicated by nine faint lines in the visible part of the spectrum. Although conclusive, this evidence is not very impressive when compared with that for other equally abundant elements. The fact is that throughout the visible and near ultra-violet, carbon atoms have no strong lines and only a few weak ones. When studied in the electric arc, however, the carbon atom is known to produce a group of very strong lines in the infra-red. The photographs obtained with the new dyes show these same lines, but, since their accuracy is greater than in the case of the electric arc, the solar data more completely correspond with the predictions of the atomic theory than do those of the laboratory.

These researches afford an excellent example of the continuity of scientific progress, which is more often evolutionary than revolutionary in character.

Excavations at Ur, 1929-30.

By M. E. L. Mallowan, M.A.

A member of Mr. Woolley's expedition here describes the latest discoveries at Ur. The new evidence relating to the beginnings and the end of the city's history, makes it clear that the measure of man's success in Southern Mesopotamia, then as to-day, was his ability to cope with the water problem.

By the end of March, 1930, the joint expedition of the British Museum and the Museum of the University of Pennsylvania, had completed its eighth consecutive season in the field. Mr. C. Leonard Woolley, the director, once again had ample reason to be satisfied with his campaign. The programme consisted of three main items: the excavation of a pre-historic site over an area large enough to be capable of supplying copious evidence of the beginnings of the city's history and the context of the Flood; the completion of the Royal Cemetery and the establishment of its confines; and, lastly, the excavation of the main city wall and the canal system.

The Prehistoric Background.

The first two tasks proceeded concurrently, and kept a gang of some two hundred men busy from the beginning of November till the middle of January. It is no small tribute to the powers of work of the supposed congenitally idle Arab that by the middle of March the complete circuit of the city wall, some two and a half miles in length, had been compassed. Above all, Hamoudi, our well-tried Arab foreman and his three sons, deserve a full measure of praise for an indefatigable energy that stimulated the vigour of the gangs under their charge and developed the intelligent enthusiasm of the more skilful pick men.

For the pre-historic dig a site roughly 600 square yards in area was selected within the Temenos. This particular site was chosen for two reasons. First, because it had been considerably denuded in antiquity, and the uppermost level could be dated by its pots-herds to before 3200 B.C., and secondly, because it lay in the vicinity of deep pre-historic rubbish heaps large and rich enough in content to indicate that the higher ground from which they had accumulated was a mine of early habitation. Yet though work was begun at a level containing buildings over 5,000 years old, the gangs had to descend sixty feet into the bowels of the earth through a continuous series of occupation levels before virgin soil was reached. Here we laid bare the pre-historic background for the picture of greater Ur as revealed to us in the Royal Cemetery and in the city fortifications of the second millenium before Christ.

From the surface excavation proceeded through eight distinct strata, each of which contained private houses built in mud brick. There was considerable change in the character of the brickwork for the different levels. There were plano-convex mud bricks, oblong flat top bricks, and in the eighth level walls of heavy limestone foundations. The variety of construction is, perhaps, an index of length of occupation, but most decisive is the thickness of the walls, often as great as sixteen feet. This means that a fair period of time must be assigned as an average occupation length; for houses so substantial in construction cannot have been rapidly abandoned. An average length of fifty years for each level can hardly be considered excessive, and may be considerably short of the mark. Moreover, the objects associated with the houses showed a definite change in character according to the depth at which they were found. From the floors of beaten mud, a mass of pottery was recovered and associated with distinctive levels, gave a type series of inestimable value for the most ancient periods of the city's history.

Painted Wares.

The most striking feature was the emergence of painted wares as opposed to the plain undecorated wares that characterize later Sumerian history. From the fourth level came a peculiar form of painted pottery that has been termed "Reserved slip ware," the paint being applied to the whole body of the pot and then wiped off at intervals so as to produce a series of striations. Lower down came a brilliant three-coloured ware in black, red, and buff, and splendid specimens of plum-coloured wares already found at Jemdet Nasr, a pre-historic site in the neighbourhood of Kish. Here was another marked phase in the history of early Ceramics. In the ninth occupation level there was a sudden change. Instead of private houses, a level of kilns for the baking of pottery. Here were found kilns with the pots neatly stacked inside as they had been left from the last firing, puddling

basins of cement bricks for the kneading of the clay (Fig. 1), and throughout this level a mass of wasters, the throw-outs of the early potter. In this rubbish at a depth of twenty-eight and a half feet below the surface was found the statuette of a soapstone boar, the earliest piece of stone sculpture in the round ever found in Mesopotamia. Executed in about 4,000 B.C., conventional, at the same time lithe and vigorous, with a real feeling for nature, it is a new adornment to the gallery of ancient art (Fig. 2).

The Great Flood.

Beneath the kiln level at a depth of forty feet below the surface of 3200 B.C., we again uncovered the great flood bank. In the previous season the bank had been discovered in trial pits of more modest dimensions. Here it was unmistakably revealed for the benefit of those who still doubted, over a far larger area. A great belt of clean sand approximately 11 feet deep, entirely devoid of building. But intrusive in it were graves, and some of their occupants must have been contemporaneous with the Flood. These burials again afforded striking evidence of a different cultural phase. Instead of being slightly flexed as in the historic period, or crouched as in the Jemdet Nasr period above the kiln level, the bodies were fully extended (Fig. 4); the painted pottery dedicated as offerings in the graves was of an entirely different type, consisting of plain bands of black on white or greenish clay, or designs in chocolate brown on a reddish clay. The earliest burials were laid on a pavement of potsherds, and the designs were richer and more elaborate, the shapes more varied.

But the most important hall-mark of a high antiquity is the hand-made as opposed to the wheel-made pot. All the Diluvian and ante-Diluvian pottery from this site is hand-made. In the kiln level the chance finding of a potter's wheel corresponded with the prevalence of wheel-made over hand-made pottery. The older type of hand-made pot with its distinctive decoration gradually disappears in the later level. In a word, the Flood stratum marks the transition to a mechanical age.

Below the Flood bank in the earliest of all the occupation levels were found remains of a fallen wall of clay bricks and fragments of a reed hut preserved for us by the accident of a fire. Below them again came virgin soil; a dark viscous clay containing decayed reeds, tree trunks, and organic matter. This was the island in a marsh on which the early Ur first came into being, where, as *Genesis* tells us, "God let dry land appear,"—in other words, the alluvium that first gave *terra firma* to Mesopotamian man.

While a variety of evidence, much of which was entirely new to Mesopotamian archaeology, was being sifted on the pre-historic site, the Royal Cemetery was providing information that both corroborated the evidence from the pre-historic town and fixed its own limits, in space and time. In the previous season it had become evident that the limits of the Cemetery had been for the most parts ascertained. It was therefore highly satisfactory that the stratification of the south-west end provided decisive evidence. From seal impressions stamped with royal names we were able to date the main Cemetery to between 3100 and 3500 B.C.

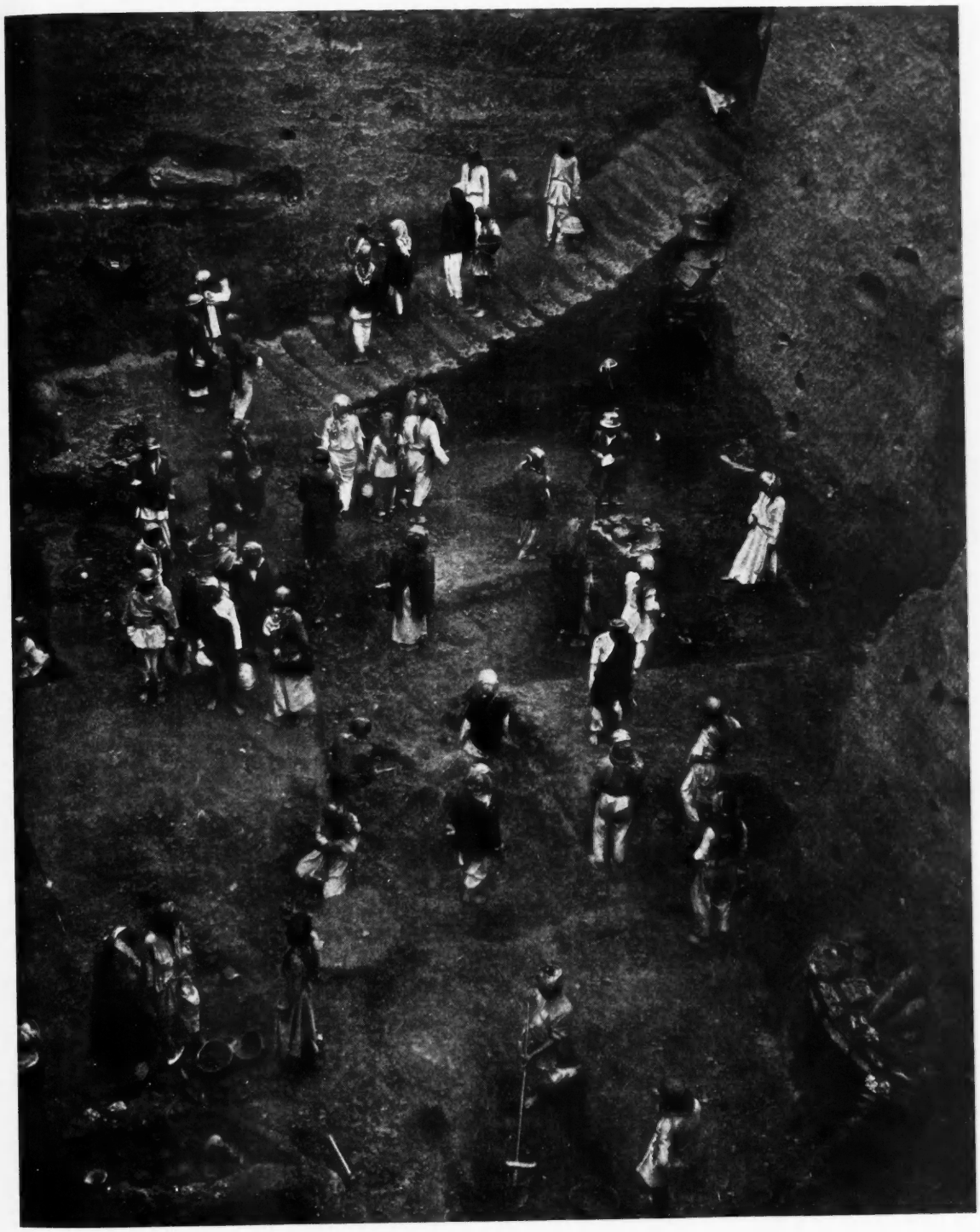
Two shafts were sunk beneath the Cemetery proper, as far as virgin soil. Here, again, the sequence of rubbish strata tallied well with finds in the pre-historic town, and there was the same gradual change from Diluvian to post-Diluvian wares. Though the treasures unearthed this season from the Cemetery were neither as brilliant nor as numerous as those of previous seasons, there was still a richness and variety of material. There was no lack of jewellery; beads and pendants of gold, silver, lapis lazuli, and carnelian. One coffin produced a splendid diadem of two gold chains supporting lapis lazuli and gold faceted beads, and an electrum dagger with a wooden handle, the pommel and hilt decorated with gold studs.

Although for scientific purposes we may consider that the main work of the Cemetery is at an end, it is obvious that there is still material to be extracted. A chance find may yet reveal a splendid treasure, but it seems highly improbable, and though here and there is still good untapped ground, the rich veins have probably been exhausted, and such graves as remain to be found are those of straggling commoners, clustered on the outskirts of the main area.

The City Wall.

Towards the end of January, the gangs joined forces once more, and from then till the end of the season, there was a far-flung line of men, feverishly disencumbering the great city wall of the debris that concealed its traces. From the top of Ziggurrat, however, its main lines could still be discerned—a great ridge with the Temenos area at its northern end, shutting off the city proper from the low-lying desert around, and from a further series of high mounds on the north-east side, the untapped hills of lesser Ur.

The uninitiated may reasonably imagine that the work of excavating a great city wall is a simple process. It might be supposed that to dig out such a huge bulwark and to clear the face of the wall, was merely a matter of sheer physical labour. Nothing is further from the truth; for the constant denundation of the



(Fig. 1.) WORKMEN EXCAVATING THE PREHISTORIC "KILN" LEVEL, BELOW WHICH LAY THE GREAT FLOOD BANK.

FIG 2.
STONE SCULPTURE OF 4,000 B.C.
Soapstone statuette of a boar, the earliest piece of stone sculpture in the round ever discovered in Mesopotamia.

ground made the task of discovering the frontage an exceedingly difficult business. Wind, rain, and the ravages of man had in many parts destroyed the original frontage, and it was often necessary to dig down to a great depth in order to uncover the wall face which remained only in its lowest level. And there was the further complication that as in antiquity itself the wall front was constantly being undermined by the action of water, the quay walls fell into disrepair, and it was necessary to build out additional quays to front the old. With the passage of time, therefore, the wall increased greatly in thickness, and often as many as three "kisus" were built on, one against the other, removing the canal line further out from the city itself.

As the walls were entirely washed by water (with the exception of some wall line at the north-west end) by the Euphrates apparently on the west side, and by canals on the remaining sides, the wall front was almost entirely built at a sharp batter or slope. Since the original face no longer remained, the wall mound had the appearance of a sharply sloping ridge running down from the higher level of the city to the low lying desert. Here and there were the remains of buildings of burnt brick; the private houses and temples that lay on top of the city wall itself; the difference of level between the floors of these houses and the foundation of the main rampart gave us the total height. The rampart varied in thickness from fifty to ninety feet, and was built entirely of mud brick which time had often fused together into a mass difficult to distinguish from the soil that encumbered it.

We have attempted to convey some of the difficulties of procedure in excavating the great wall. Let us consider the resulting picture, a picture not so much actually visible in the soil, though the evidence is all there to the expert, as deducible on paper. From the great foundations that have been so hardly dealt with by time, we can build up on paper the magnificent rampart that once was. And it is not to be thought of as a lofty wall, standing high above the plain, so much as a great barrage against the surrounding water impossible to undermine. The houses, temples, and forts, were built on top of this barrage, which served as a retaining wall for the higher ground of the city, often there was no visible inner face to the rampart, which lay flush with the higher ground of the city. In places where there was an inner face the houses were sometimes built out against the city wall itself. It appears that this great rampart was built by that Augustus of Ancient Ur, the great Ur Nammu, who flourished in about 2300 B.C., and crowned his building effort by the erection of the Ziggurrat in the heart of the city. The man-power that must have been expended on the erection of a wall of an average thickness of sixty feet, and a height of roughly twenty-six feet, for some two and a half miles, is staggering to contemplate.

The wall being entirely surrounded by water, it was necessary to construct two great harbours, one on the north and one on the west side of the city. Their area was large enough to shelter a great body of shipping, and they were protected from attack by narrow entrances, that of the west harbour was just wide enough to allow two ships to pass. All along the wall front was a quay about thirty feet in width, flanked by private houses built in burnt-brick. Such of these as remained were almost entirely of the Larsa period, *c.* 2000 B.C., similar in type to the Baghdad house of to-day, with a central court and rooms radiating off it. And as always in this period, the dead were buried in clay coffins beneath the house floors. A peculiar feature of the houses was that the doors were never on the quay front, but at the sides or facing the inner city, a feature that may still be observed on the town wall at Aleppo.

While the Euphrates flanked the west side of the city and canals the remaining side, there was also a great canal that bi-sected the inner town itself and issued from the northern harbour into the Euphrates on the west. Ancient Ur was therefore not only surrounded, but intersected by water, and the analogy with Venice will readily suggest itself.

Remarkable among the features of the wall were the numerous temples and fortifications that studded it at irregular intervals. One of these, built in the reign of Rim Sin, contained a remarkable foundation deposit (Fig. 3). Later kings often strengthened

the city and great forts of Kurigalzu, 1600 B.C., and of Nebuchadnezzar, 600 B.C., were unearthed on the east side. Among the early temples the last to be found on the wall was perhaps the most striking of all. Against the south angle of the northern harbour a fairly prominent mound invited a sondage, and it proved to conceal a temple more perfectly preserved than any hitherto found in Mesopotamia. The walls were still preserved to a height of twenty feet; beam-holes with the stumps of wood for supporting the roof were still visible, and the plaster was in many places still adhering to the walls. A pillar of burnt-brick supported the roof, and in the forecourt was a lofty burnt-brick screen. The great altar was also in excellent preservation, and behind it ran the passage from which the priests were supposed to have worked the oracle. In such splendid preservation was the temple that we roofed it with sleepers and matting, so that we may now enter the great building of Nebuchadnezzar, and penetrate its dark recesses with something of the awe that must have filled the temple visitor 2,500 years ago.

Beside the fortifications and temple strongholds that defended the city wall, there were everywhere the traces of the last occupants of Ur—the Persians. Their houses, the last to stand above ground in the ancient city, had been entirely swept away, but their graves remained—clay coffins containing a variety of jewellery, glazed beads, agate and amethystine quartz, glazed vessels, and in one of the graves, a silver fluted platter chased with a rosette on its base, a magnificent example of the silversmith's work, a solitary link with the splendid age of Sumerian metallurgy. But these same Persian graves, with their tawdry jewellery, their veneered pottery, reminded one inevitably of the decay of the great city. By the fifth century B.C., Ur was moribund. Its canal system was in disrepair. It seems an irony of fate that whereas Ur in its infancy was well-nigh overwhelmed by a surfeit of water, in its senile decay it perished through the lack of it. On the east side of the city, in place of the former broad canal, alive with shipping, there was a small irrigation trench 4 or 5 yards wide, that doubtless watered a few stray vegetable gardens. The Euphrates, it seems, had so far shifted its course, that irrigation was beyond the powers of a city whose resources were now dependent on the crippled authority of Babylon. Thus, by the end of the fifth century B.C., Ur was a deserted city.

The first traces of Ur in the island emerging from the marsh, the flood bank of the fifth millenium B.C., the great quay walls of the second millenium, and the miserable irrigation trench of the fifth century, all point a moral; that the measure of man's success in Southern Mesopotamia was his ability to cope with the water problem, a problem that taxed the resources of the ancient inhabitant no less than that of the living Arab to-day. Success brought with it great buildings, trade, and a profusion of the arts; failure, the misery and impotence that a merciless desert inflicts on him who would brave its torrid confines.

FIG. 3.
TEMPLE FOUNDATION DEPOSIT, 1990 B.C.
This copper statuette of King Rim Sin, inscribed in cuneiform characters, enables the foundation of the temple to be dated exactly at 1990 B.C.

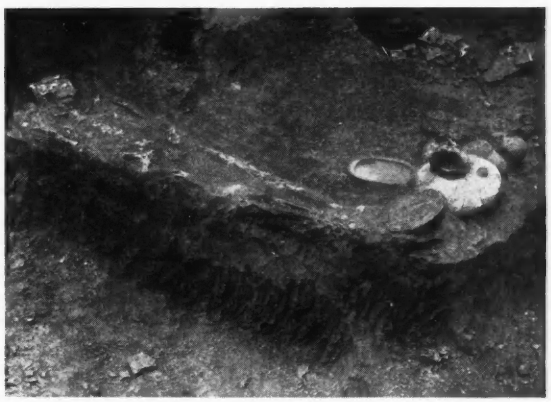


FIG. 4.
GRAVE OF THE FLOOD PERIOD.
Extended burial as discovered in the Flood stratum, with offerings of painted pottery lying at the feet. In later periods, the bodies were slightly flexed.

Catching and Curing the Bombay Duck.

By James Hornell, F.L.S.

Late Director of Fisheries to the Government of Madras.

An ancient native industry is the subject of this article, which describes the production of a table delicacy much relished in India. The superstitions of the sailors provide an interesting field for study.

THE Bombay Duck does not sport feathers, as everyone is aware who knows anything about a real curry as opposed to the miserable counterfeit concoction of the untravelled European chef. It has a body encased in a sheath of delicate scales, and is indeed a fish, though to look at when it appears on the table to give relish to our curry, it has much the appearance of a fragment ripped off an Egyptian mummy !

Diu Island.

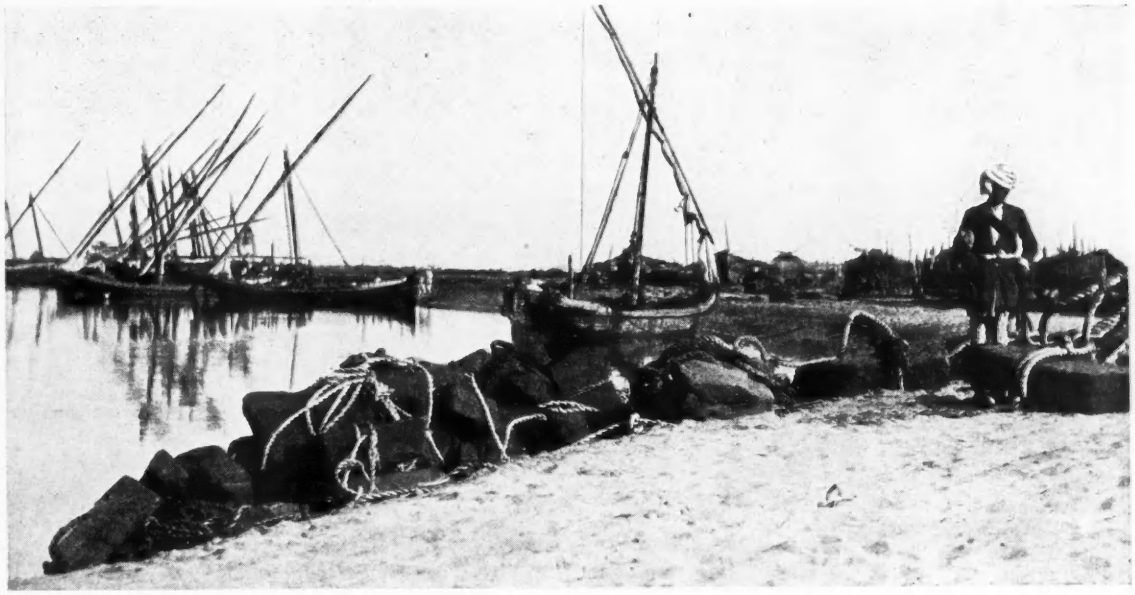
Few Europeans ever see it in the flesh or undergoing the primitive curing given it before being shipped to Bombay, the world's emporium for this delicacy. It is found in greatest abundance off the Gujarat and Bombay coasts, and more particularly off the wide and shallow entrance to the Gulf of Cambay. Diu Island, an important outpost of the Portuguese when they were the lords of the seas and coasts of India, is one of its greatest fishing centres ; in the season, October till April, scores of large fishing boats from the Portuguese towns on the Gujarat coast go there to engage in the Bombay Duck fishery. These boats are trim weatherly craft, of about twenty tons register, built of teak throughout and intended primarily as cargo carriers. They are, indeed, the finest wooded vessels plying on the coasts of India ; formerly their dimensions were much greater, the shiprights of Gujarat and Bombay frequently building boats up to one hundred tons and possessing skill adequate to the construction of much larger ones, now, alas ! no longer required. It is worthy of remembrance that many a stately King's ship and stout East Indiaman was built in the Bombay naval yard, in the spacious days of John Company, by the same class of shipwrights as those few surviving in Gujarat.

In the construction of the smaller craft, with which we are here concerned, the planking is most ingeniously fastened together by a system of double tongue and groove jointing. The grooves and tongues are fashioned by the shipright by means of a curiously dumpy adze ; he disdains the use of lines and gauges, depending entirely upon his eye as a guide. Before any plank is fitted permanently into position, the upper edge of the next lower strake is smeared first with a coating of red ochre and then with another of gum damar boiled in oil, over which is spread a thin layer of raw cotton.

In their rig these boats are single masted, hoisting the local form of lateen sail. Except for a short decking at each end, they are open, but when engaged in fishing the waist is decked over with a temporary flooring made of split bamboos. On this the men drowse and sleep during the hours when they lie to their net awaiting the turn of the tide. The crew of each boat numbers from seven to nine. By religion the majority are Hindus, by caste Machhis or fishermen, a community despised by high caste people, a condition which has been of the greatest assistance to the missionary in his efforts to convert this class to Christianity ! They are decent, quiet folk, who put into everyday practice a simple form of communism. Among the crews there are neither masters nor servants ; every man of them has his own appointed duty, and the produce of their common labour is shared equally among the men in each crew. Each man brings two bag-nets, together with the necessary gear of ropes, buoys, floats, etc. The owner of the boat, or the man who hires it on behalf of the venture, receives an equal share with the others as his remuneration. For this he has also to maintain the boat in perfect sailing order. So long as she is on the fishing station, all subsistence expenses, the cost of food and drink, and so forth, are defrayed from a common fund, the net profit being divided at the end of the season.

Sun-Scorched Fishermen.

The fishermen are a lithe, muscular, sun-scorched crowd. Burnt a dark shade of brown, exposure to sun and sea-spray dries their skin so thoroughly that it is no uncommon sight to see them make some simple calculation, perhaps a rough reckoning of the day's catch and its value, by scratching the figures on the skin of the thigh, a sliver of wood, or even the finger nail serving as the pencil. Figures so made stand out white and conspicuous, and are easily read upon the dark brown skin.



ANCHORING STONES USED FOR THE FISHING NETS.

Where the water is too deep for stakes, piles of stones are used to anchor the nets, which are kept extended by bridles attached to the stones. The cost of these stones is a heavy annual expense to the fishermen.

The appliance used in fishing is an enormous bag-net. If the water be comparatively shallow, as off the Bombay coast, say up to eight fathoms, each net is secured by four short ropes to two huge posts driven into the sea bottom. The nets are conical in shape when extended; they average 150 feet in length with a circumference at the mouth of 250 feet. The meshes decrease gradually from four inches square at the mouth to half an inch or less at the cod end. To the latter is attached a seven-foot length of netting, which serves as a funnel for emptying the net into the boat after opening the cod end.

Off Diu, where the greatest catches are made, the water is so deep that stakes cannot be used, and the nets have to be extended by means of four long bridles attached to two piles of anchoring stones, placed about forty-five feet apart. Each pile consists of twenty great rectangular sandstone blocks, each about a hundredweight or more in weight, with a hole in the centre for the passage through of the stout ropes which tie them together. They are curiously made ropes, for each of the stout strands is made up of twisted leaflets of the date palm wrapped round with strips of the leaf of another palm, the palmyra, or toddy palm. When the piles of anchor stones are laid out at the beginning of the season, two palm leaf bridle ropes, about seven inches in circumference, are made fast at the lower ends to each pile of anchor stones. One of each pair of bridles, longer than its fellow, is buoyed by a large log of light wood, while a strong cord runs also from this buoy to the free end of the second rope.

To set the net, the ends of the four bridles are taken aboard and attached at equidistant points on the circle of the mouth; to keep it distended, a barrel float and two wood buoys float up the upper section of the net's mouth and serve also to locate its position. Nets are overhauled and emptied before the turn of the tide, either at the end of the flood or of the ebb, and reset at the beginning of the ensuing ebb or flood. One boat usually works several nets, either two or three when they are set to stone anchors, four, or even more, in the case of staked nets. In the traffic crowded waters in the vicinity of Bombay, these stake nets are a standing menace to shipping, and necessitate great care when navigating during the night. A strong tidal current is needed to maintain the nets in distended working order; during neap tides, from the 7th to the 11th, and from the 22nd to the 26th of each lunar month, the current being too slack for this purpose, the nets are detached and taken ashore for repair, and, when necessary, for barking.

At the end of the season the anchor ropes are cut away close to the stones and utilized the following season as lines on which to hang the fish while drying. The stones are too heavy to be removed, and so are

MENDING THE NETS.
The nets used for catching the Bombay Duck are of conical shape, about 150 feet in length and having a circumference at the mouth of 250 feet.

lost to the fishermen at the end of each season. As the piles in use are fixtures and as the shoals cannot be counted upon with certainty to be found at one particular depth, each crew generally lay out anchor heaps of stones at two different depths, one at three to five miles from shore, the other six to eight miles seawards, according to the depth of the sea at the place they are fishing. The cost of these stones is a heavy annual expense. Those who can employ timber stakes are under much heavier initial expenditure, but when once set up they last for years.

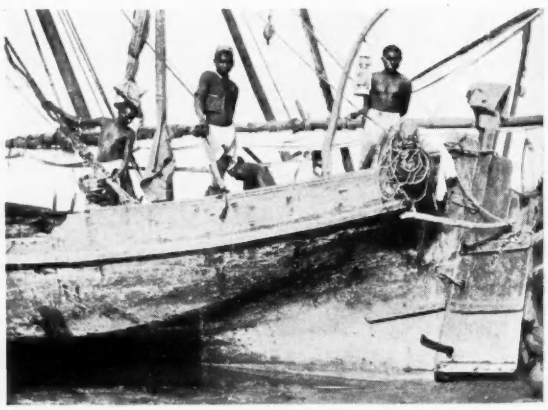
The *bumla*, as the Bombay Duck is called in the vernacular (its scientific name is *Harpodon nehereus*), is a gregarious fish, hunting for food in enormous shoals, the prey consisting of prawns and other small crustaceans. It runs from seven to nine inches in length; the body is slender, nearly cylindrical, pale and almost translucent in appearance when alive, its flesh soft and flaccid in consistence. Its voracity is vouched for by the great stretch of its jaws, armed with strong needle-like teeth, well fitted to seize and hold fast its prey.

If the bag nets happen to be set in such a way as to lie athwart the path of these shoals, huge catches are made, but alas! no care is taken to prevent damage to the fish and everything emptied from the net is slithered into the bottom of the boat; the little bumla, a few inches long, edy-higglpiggledy with giant bass weighing forty to fifty pound each. A second, and sometimes a third catch may at times be emptied on top of the first caught fish, and it may be even twenty hours before the boat returns to port, so eager are the men to catch everything possible when shoals are passing by in exceptional abundance. When this happens, the first lots become tainted and unfit for food long before they reach the shore.

No salt is ever used either afloat or ashore in the treatment of the bumla. Such as are deemed fit for curing—and the curer interprets this quality most liberally—are sorted into baskets by women and rinsed in sea water by the simple process of a deft rotation of the filled basket to and fro for a minute. To dry them, the fish are hung in pairs astride wornout and discarded anchor ropes stretched between upright poles, the under jaw of one thrust through that of the other, the long sharp teeth acting as retaining barbs. For market they are packed in large flat circular bundles, twenty-four to thirty inches in diameter, each containing 2,000 fishes. According to the size of the fish, so the bundles vary in thickness and diameter; thin fishes are said to be better flavoured and more delicate than the larger and thicker ones.

Pieces of old netting are used to secure the bundles which have no other covering, and are therefore exposed to contamination of all sorts. Much as the Bombay Duck is esteemed by Anglo-Indians (old-style!), it is questionable if it would be such a favourite were they to see the crudity and lack of cleanliness chacterizing its preparation. However, what the eye does not see, the heart does not grieve for, and it is as well to remember that only of recent years has the preparation of several items relished in our own cuisine been above suspicion.

Well prepared bumla in first-class condition is a deservedly esteemed savoury, but it scarcely merits comparison with the equivalent dainty so greatly relished in Northern France and the Channel Islands—

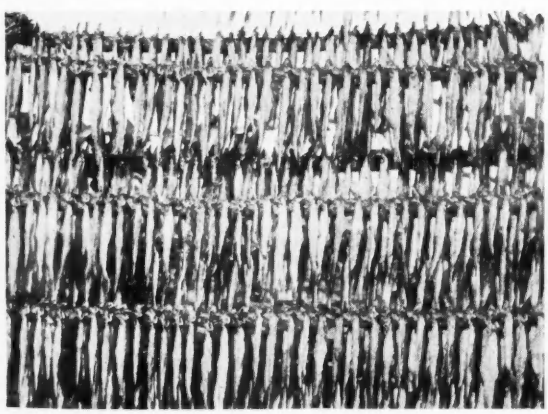


A TYPICAL CREW.
The fishermen work on a communal basis, each member of the crew sharing equally in the proceeds of the catch. They belong to the Machhis caste.

the toothsome *caplin* brought home from the Newfoundland banks by the cod-fishing fleet of picturesque sailing vessels, which hail from the northern ports of Brittany. Just as the immense shoals of caplin serve to attract multitudes of cod to the Newfoundland banks, so do the myriads of bumla serve as an attraction to the great *ghól*, the magnificent golden-mouthed Corvina (*Sciaena aquila*), which on the north-west coast of India follows the shoals of small fish into certain favoured bays. In exactly the same way it does so on the north-west coast of Africa, where, in Levrier Bay, under the lee of Cape Blanco, it is one of the greatest and most historic seasonal fisheries in the world—the annual resort for four months in the year of a great fleet of Spanish fishing schooners from the Canary Islands.

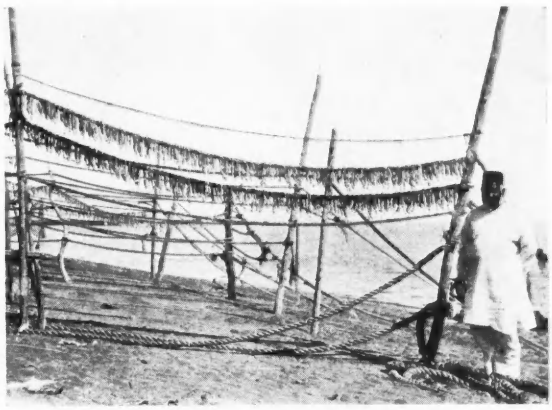
An interesting accessory industry of the Indian fishery, is the preparation of the swim-bladders of certain fishes, those of the ghól being the most valuable, for export as "fish-maws," the raw material from which isinglass is manufactured. These bladders, after being soaked in sea-water to wash off blood and dirt are dexterously ripped open in an ingeniously simple manner; a long, slender knife of razor-like sharpness is hinged at the top of a groove in a long tapered cone, upon which the bladder is drawn in the same way as a glove finger upon a digit. When laid open by levering the knife upwards, the vascular lining membrane is peeled off by hand, leaving the connective tissue wall of the bladder snowy white. Thereafter it is dried in the sun on horizontal sheets of cocoanut-cord netting raised on poles a few feet above the ground.

These Hindu fishermen are very superstitious, and sacrifice to local deities for success and safety at sea.



CURING THE "DUCK."

In order to hold the rows of fish together during the drying process, the jaw of one fish is thrust through that of another, the long sharp teeth acting as barbs.



THE DRYING APPARATUS.

The drying apparatus consists of anchor ropes stretched between poles. For market the fish are packed in bundles, each containing 2,000 fishes.

The most celebrated shrine is that of Madhvar Devi, on a bold and dangerous headland near Diu. Here has been erected a tiny four-square shrine. The goddess is represented in low relief on an upright slab within. A little skirt of faded Manchester cloth is hung across the image, just above the waist; the rest of the figure is daubed thickly with many successive coatings of vermilion paint. The fishermen sacrifice goats and fowls before the shrine and lay small portions at the foot of the image, thereafter taking the offerings to their camp to eat! No accredited priest takes the simple service, which is carried through by one of the older men; the killing of the sacrificial animal, the sprinkling of its blood before the goddess, and the smearing of a little vermilion upon the deity's face is sufficient ceremonial. Such sacrifices are made at the beginning of the fishing season, and whenever a long spell of bad luck has been experienced.

In time of danger at sea, Hindu sailors and fishermen act precisely as do men of like profession in the Mediterranean; they vow an offering to the deity of their home shrine if their prayers for safety be answered. Those of one little port in South India when in danger of shipwreck take special precautions to impress on their protecting goddess the earnestness of their vow; they wrap a rupee, the usual offering, in a piece of cloth, and nail it to the mast. The superstitions of Indian seafaring folk are, indeed, a fruitful field for study; they believe as a rule in the evil eye, and mark their boat in diverse ways with a view to neutralizing the malignant influence. Most common, perhaps, is where, among orthodox Hindus, the symbol of the central deity of their cult is employed—the three horizontal bars denoting the worship of Siva being most in evidence.

Coal from the Air: A Chemist's Prophecy.

THE prophecy that coal gas would before long be obtained from the air was made by Dr. Herbert Levenstein, President of the Society of Chemical Industry, in an address at Birmingham last month. Referring to the wonderful development of dyestuffs as one of the greatest achievements of recent years, he said that a century ago the distillation of coal to produce gas must have seemed very unlikely to lead to a chemical industry. The smelly, crude gas was required for lighting. It had to be "scrubbed" if only because otherwise the tar was deposited in the pipes. This coal tar, a sticky black material, became interesting later, when it was found that it could be distilled and separated into pure organic chemicals, such as naphthalene, toluene, and above all, benzene. Then it was discovered how to turn benzene into new and more brilliant dyes, attractive perfumes, and popular drugs. To-day, however, it seems a dreadful weakness to have to use as raw materials for these industries the tar from those black, long-buried fossils, degraded celluloses, dead plants, and old forgotten forests. Æons passed before they could be used, yet the carbonic acid of the air is the sole source of the carbon contained in coal. The tree and plant know how to convert this acid into cellulose—the source of coal, coal gas and coal tar. Wind and rain, sun and soil—Aristotle's elements of earth, air, fire and water—are the raw materials of our organic chemical industries. A little sulphur they must have; a little of the halogens; some sodium and lime. The rest is derived from the growing plants or from the animals that live on plants. If we except mining and metallurgy, the various applications of metals and a few rocks and minerals, this is true of all our main industries. Above all, it is true of our very important raw material, Power.

"Living on Air."

It is becoming a matter no longer of choice, but of necessity, for the human race to learn to use the air, soil, and sun to the best advantage to make the earth more productive of food and raw material. This is one of the two great tasks of science. The other is how to decrease human suffering by the conquest of disease, which would follow slowly but surely upon an increased knowledge of the subtle chemistry of the living cell, of which so little is yet known. The discovery of how to use the nitrogen of the air to increase the productivity of the soil will remain one of the greatest landmarks in human achievement. But what a contrast there is between the high pressures and high temperatures of the huge plant at Billingham-on-Tees for the synthesis of ammonia, and the gentle methods of Nature in the roots of the leguminosæ. That is the characteristic difference between synthetic and natural methods.

Having tapped the inexhaustible supplies of atmospheric nitrogen, Dr. Levenstein continued, the next step is to transform another constituent of the air, carbonic acid, without the intervention of the plant, and thus to get, without the interval of a geological age, the raw materials now obtained from coal. The complete reduction of carbonic acid to methane (coal gas) has, in fact, been accomplished. It will certainly not be long before methane becomes a valuable raw material of the chemical industry. It could, in turn, be almost completely converted in the arc oven into acetylene, and acetylene could be polymerized to a tar about half of which consisted of benzene. Thus we obtain, by the synthetic, instead of the geological route, direct access to a new source of the products obtained from coal tar. Our available raw material would thus become inexhaustible.

Passing of the Coal Age.

National wealth is reckoned in terms of coal or oil, that is, of energy stored up geological years ago. Dr. Levenstein said that the weakness of Great Britain as a manufacturing country is its dependence on fossil-wealth—that is, on coal—for power, instead of on the tides, the waterfalls, the wind, the direct radiation of the sun. Other countries are developing the use of water power for industries on a scale that seems stupendous compared with the small scale still predominant in this country. Power is being used in increasing amount per head of the population in all industrial countries, and much more rapidly in other countries than here. It is essential we should have the raw material, power, as cheaply as, if not more cheaply than, other nations. Another ten or fifteen generations would see the exhaustion of the world's principal coal deposits. The age of coal is passing. It will have lasted, when it is over, for a less period than the Moorish occupation of Spain, which at the time seemed so important to Christendom, and vanished leaving behind it nothing but a garden here and there, a palace or two preserved by the conqueror's pride, and a few romantic tales.

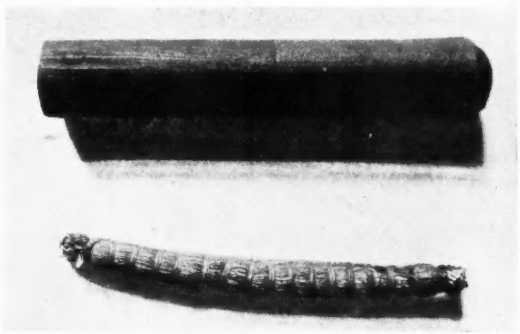
Medicine-Men and their Cures.

By Captain W. Hichens.

Late of the Native Administrative Service, East Africa.

Many discoveries in tropical medicine were anticipated long ago by the African medicine-men, whose methods are much more scientific than is commonly supposed. The author discusses the subject from first-hand observations, and shows how largely psychology is employed in the native cures.

By the new laws against witchcraft, passed recently in Swaziland, Kenya, Tanganyika, and elsewhere in British Africa, it becomes a penal offence for a native to practice as a witchdoctor. But it is interesting to note that they do not seek to suppress those wizened and rheumy-eyed old gentlemen to be found in the backveld kraals—the medicine-men. Though the two are often confused, there is a vast difference between the native witch-doctor and the native medicine-man. Where the witchdoctor deals in spells of evil, charms, and black magic, and is the familiar of ghosts and demons, the medicine-man, on the other hand, is the savage's medical man. His business is to prevent, detect, diagnose, and treat the diseases to which the savage and his animals are prone, and to deal with the wounds and accidents which are all too common in a country where wild beasts, snakes, thornbush, and such minor pests as scorpions, chigoe-fleas, tsetse, and tumbu flies abound.



NATIVE POISON BOTTLE.

A poison-sachet used by the medicine-man to contain poisonous material is here shown, with (above) the bamboo tube in which the sachet is carried.

In the backveld kraals, where the white doctor may come out on *safari* not oftener, perhaps, than once a year, the *mganga* (as the native calls his medicine-man) is the surgeon, physician, neurological expert, herbalist, toxicologist, and veterinarian. His skill is one of the amazing factors of primitive savage life. For despite the popular notion that the lore and ritual of the savage medicine-man are no more nor less than the sheerest mumbo-jumbo, he is, in fact, an expert in his profession. In their own mysterious way, the secret clans of the medicine-men have discovered cures for diseases which still baffle white medical science. Indeed, they hit upon great scientific truths generations ago (and long before white men set foot in their tribal districts), which have only recently been hailed as among the triumphs of twentieth century scientific research.

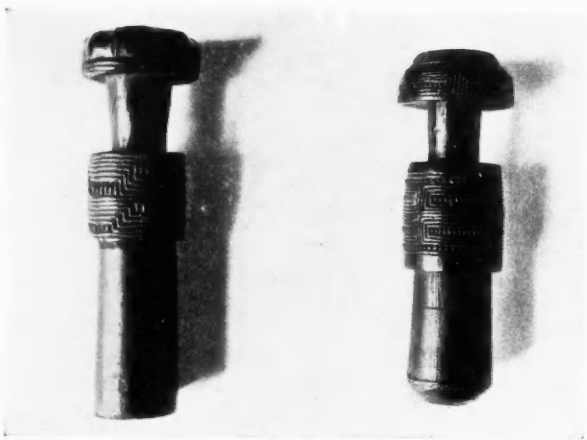
The great warrior and cattle ranching tribes of Kenya, the Masai, the Lumbwa, and the Nandi, knew long before the fact was discovered by veterinary research, that the redwater plague in cattle was caused by the bite of a grass-tick (*Ixodes spp.*). Their medicine-men gave it a distinctive name signifying "red-water," while their stockmen adopted preventive and curative measures very similar to those advocated by science to-day. The most practical of the native methods was the burning at suitable seasons of vast acres of dry pasture grass, when the fire destroyed the ticks and left behind it a broad trail of clean grazing. The medicine-men devised *dawa* or "magic" medicine to cure redwater, and it is significant that with the Masai one of their tribal cattle cures includes urine (for ammonia), iron rust, and nux vomica, which are practically the three main ingredients of the cattle tonic now commended for the later stages of this plague.

The African savage also discovered of his own intuition that what the Kaffir calls *inapunga*, and the Boer *boschziekte* or bush-sickness—heartwater in sheep—was also caused by the bite of a tick, *Amblyomma hebraeum*; but, like the modern veterinarian, the native was baffled to find a cure for this scourge. He did what he could, however, in pasture burning, and attributed the high mortality in his flocks to the baleful intervention of the devil.

In *homa* or malaria, the great scourge of man in Africa, the savage medicine-man made even more

notable discoveries. He knew, generations before Sir Ronald Ross drove the fact home to our incredulous world of science of thirty years ago, not only that malaria is transmitted by the bite of the mosquito, but that the fever was caused by minute organisms and that the prophylactic for it was quinine. At the time when science was averring that malaria was caused by inhaling the gases from swamps and marshes, the old medicine-man, crouching over his steaming pots of herbs and roots, had linked that whining pest of the sunset, *mbu*, as the mosquito is called, with what the kraalsfolk would describe as a feeling like "millions and millions of tiny insects in one's blood." The savage, of course, had no conception of the malaria plasmodium as such, but he had puzzled out that there seemed to be "things" in his blood which made him writhe and itch with the fever. For want of a better word he called them *vidudu*, which means anything "insecty"; and, for want of a better word, not being certain how it really should be designated, our own bacteriology still refers to the malarial agent as a "parasite." But the savage linked the mosquito with malaria before that great fact occurred to the white man: some tribes even made *mbu* their totem.

The medicine-men were not baffled to devise a *dawa* for this insect-fever. They discovered the bark of a forest tree, shredded it, pounded and crushed it, infused it in water, slaughtered black goats to the gods to imbue it with magic, muttered incantations over it by the light of the full moon; mixed it with strange things, the blood of enemies slain in battle, the ground burned bones of lions, the crushed bodies of mosquitoes, the inflicters of ill: and this great medicine was strong, bitter and black to the taste—for it was quinine. What flash of genius (like the inspiration that urged Ross, Lister, and Pasteur) could have moved some half naked medicine-man, strung with his girdles of gourds and charms as he trod awesomely down some forest trail, to prize off with his raw iron knife the bark of the cinchona, we shall never know. Suffice it, that infusions of cinchona bark became the medicine-man's magic *dawa* for the insect-fever of *mbu*, the biter.



CARVED WOODEN BOTTLES.

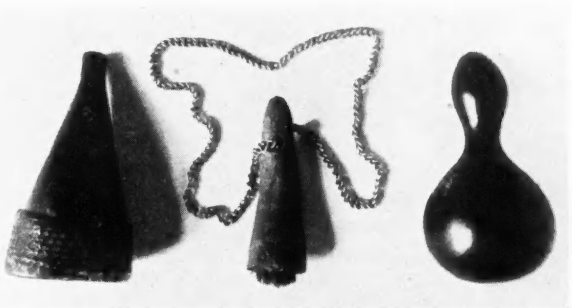
Another variety of medicine container, made of wood, used by the native doctors as receptacles for herbal powders. Notice the delicate carving on the corks and bottles.

But the medicine-man has many such medicines made from roots, bark, berries, leaves. One of the most striking is a fire-proof ointment used by the Akimbu snake-dancers in Tanganyika. These professional dancers travel from village to village, giving exhibitions of fantastic snake charming and of remarkable fire dances in which the performers seize blazing brands of wood and charcoal, bite fiery chunks from them, rubbing their faces, arms, chests, and legs with the flame and fire of the wood. But beforehand, while the crowd is gathering around their drummers who are announcing the performance, the dancers run off to a nearby belt of forest and gather the leaves of certain shrubs and trees. These they chew into a paste, and with this they mix *dawa*, a blackish powder which they have previously obtained from their medicine-man, whose secret it is. This concoction they then smear over their bodies, and, though they sit, roll, or dance in the blaze of the fire, they emerge unscathed, nor do the flaming brands make a mark upon their skins.

These people, also, have a singular antidote for snake poison. Not long back in the bush I came across one small Mkimbu boy sitting patiently beside another small boy, who was prone and apparently dead on the ground. Thonged and impotent in a forked stick by his side writhed a vicious puff-adder, which he had caught early that morning and which had bitten him. His companion told me that he had been lying so for some four hours, and I naturally thought his case was hopeless, but his companion was much amused at that. It was quite usual, he said, for them to be bitten by snakes which they caught for their elders, the snake-dancers, and the bitten lad had incised his wound with their medicine-man's *dawa*, and swallowed some of his powders in water, and in a few minutes he would be quite all right: and, in fact, within a short time he was. One of the Wakimbu medicine-men has informed me that this snake *dawa* contains snake-venom,

ground snakes' scales, and snakes' tongues as some of its ingredients, but what its other components were the old man would not divulge. Snake venom, of course, is one of our own anti-toxic treatments for snake-bite. The Wayeye, another clan of snake-dancers in Tanganyika, have also some thoroughly effective *dawa*, made by their medicine-men for snake-bite cure.

For the everyday ailments of the kraal, the medicine-man has an extensive pharmacopaeia of medicines, whose efficacy has not only been tested out over tribal generations, but is a matter of daily experience in the native village. One in common demand in the summer-time, when the beer-pots froth, perhaps a bit too enticingly, is a headache cure, *mtimburi imbwe*. This is made from nodules cut from the bark of a certain tree, ground down on a stone and mixed with water to form a paste, which is smeared over the forehead, and which, as I can testify, would appear to have definite anaesthetic properties. It certainly cures headache. Another mysterious medicine which has definitely tonic effects is *Tschichanyanja*, a root which the medicine-men will only collect from the forest on certain nights when porcupines are to be heard.



MEDICINE SPRINKLER AND CHARM.

On the left is a powder sprinkler from which doses of *dawa* are measured. Centre: Charm-medicine, or herbs with pastes put into a dikdik horn as a talisman against rheumatism. Right: A small gourd, carried on the doctor's belt as receptacle for fluid medicines and powders.

Despite the foul water and often tainted meat which natives sometimes eat, and the hordes of flies and often insanitary conditions, dysentery is not a very prevalent disease in the villages. But natives frequently contract it upon a journey to some neighbouring kraal, and they then have recourse to *manga nayaya*, a medicine made from tree roots. The roots are split longitudinally, and the fibres separated, and they are then tied together at both ends.

Perhaps one may find here an instance of symbolic magic, typifying the "fastening," as it were, of the alimentary canal. The tied fibres are soaked in hot water and the infusion is given as a medicine, to be taken in the quantities of half a pint three times a day for three days. The limit of three days is typical of the medicine-man's prescriptions, for he is not only confident of his cure, but he is definite as to when it will occur. Three, also, is a magic number.

Another remedy made from tree roots is *Chiwanga*, which is applied as a paste to small incisions made in the scalp of sufferers from neuralgia. *Chipinda*, a similar medicine, is applied to incisions in the flesh on the ribs as a cure for bruised ribs: and numerous such medicines are in use to cure boils, abscesses, and skin eruptions. Mention must also be made of *milikila*, a remarkable tonic and partial anaesthetic given as a beverage to expectant mothers. Preparations of earth taken from the queen-chamber of termite hills are also used in the native's obstetric practice.

In addition to beneficent medicines, however, the *mganga* has naturally turned his attention to poisons, and most medicine-men are experts in the subtleties of toxicology. Some of the commonest poisons are prepared from roots, such as aconite. The medicine-man cannot be entirely absolved, perhaps, from aiding his satanic *confrère*, the witch-doctor, on the toxicological side. For there are a number of poisons which one may use to "remove" an enemy or a backbiting neighbour, by the simple means of sprinkling the growing corncobs in his grainplot with a subtle concoction, mixing tasteless powders with his food or beer, or even sprinkling tiny but remarkably vicious thorns, besmeared with poison, on his sleeping mat. Poisons for hunters are widely made, and are often so virile that the merest smear on an arrow or spear head will bring down a buffalo or an elephant within the span of sunrise to sundown. Such poisons are often done up in small sachets made of grass, cigar-shaped, and dexterously bound: and these are usually kept for safety's sake in small bamboo or hide cases.

The native medicine-man has ventured into experimental realms, and it is a remarkable fact that he discovered vaccination before Jenner was born, and innoculation against disease generations before Pasteur ever stabbed a culture. Working amongst the Iramba and Atatoga of Tanganyika I found that most of the kraalsfolk had been vaccinated by their medicine-men. Their method was crude: the *mganga*, getting news of a case of small-pox, would visit the patient, having first cloaked himself with a kind of

antiseptic "magic," and collect the excretions from the sufferer's pustules. This *dawa* he used as his primitive serum, inoculating it into rows of small slits cutting the skin of the foreheads or shoulders of those who came for treatment. In much the same way, witchdoctors "bewitch" their victims with leprosy: by collecting the pus and exudations from the bodies of lepers and inoculating by thorns and other insidious means set in the victim's path.

Just as the savage linked the mosquito and malaria, he saw the connexion between the hideous beanlike tick which lurks in the cracks of his mud-walled huts and the folds of his sleeping mats, and the plaguing recurrent fever. By what process of thought the medicine-man worked out that the bite of the spirillum tick (*Ornithodorus moubata*) could itself give immunity from spirillum fever is a mystery, unless we can find the solution in a kind of imitative magic working on the principle that ill defeats ill. Suffice it that in West and in parts of East Africa, natives in spirillum-tick infested districts carry pet ticks in small bamboo cases, and, when they feel an attack of fever is likely to become imminent, they let the ticks have a good feed on their arms and so acquire the requisite vaccinative infection.

The great achievement of the black medicine is perhaps in the psychological realm, for there can be no question that many medicine-men possess hypnotic and auto-suggestive powers of a high quality. Surrounded by witchcraft and all the terrors of superstition, and beset at every turn by omens and the machinations of the ghosts and spirits, the native is peculiarly susceptible to what psychology interprets as self-hypnosis and traumatisms, imaginary conditions of sickness and ill. It is by no means unusual for one native to visit a witchdoctor and fee him a goat to bewitch another native with, say, a splitting headache, a stiff arm, a lame leg, impotence, or even a spell of death. These spells work with such force of terror upon the native mind as not infrequently to bring about the exact condition of sickness or infirmity that the witchdoctor has decreed.

A Scientific Basis.

It is then that the medicine-man's skill is sought. His methods are often fantastic: he may boil a brew of herbs and cast magic stones, or hold a great drum dance to exorcise the devil of the ailment. He may even pretend to produce a live toad from the sufferer's liver, or a handful of nails, broken glass, and pangolin claws from his brains. But the essence of his cure is scientifically sound, for he quells the imaginary, self-hypnotic ailment by the overwhelming force of his own suggestivity. The *mganga* would not be an African were he not to surround his genuine cures with all the fantastic mumbo-jumbo of mystery and magic: but behind it all is a very real grasp of some of the main elements of medical science, and in matters psychological this grasp is often intense. Recently in Rhodesia a young witchdoctor, arguing with an old *mganga*, jeered at his elder's skill. "Ha!" said the old man, "were I to command it, you would drop dead!" "Huh!" sneered the youth, "try it!" In a very old voice the old *mganga* spoke the words, "Now you will die!" For a few seconds the youth stood, swaying, and then fell to the ground. A nearby white doctor certified that he had died of "heart failure." One need, perhaps, be no psychologist to link this heart failure with that dominant urge to die with which the old medicine-man imbued his death-command.

River Polution Problems.

FURTHER research into river pollution is among the objects stressed in a pamphlet just issued by the Fresh Water Biological Association. Far too little is known of fish diseases and the conditions which lead to their becoming epidemic in a river or lake. The importance of the problem is illustrated by "furunculosis," which affects salmon and trout rivers where it may cause great havoc among the fish. The disease is caused by a bacterium, which cannot survive in absolutely pure water but arises in water polluted by organic matter.

In combating a disease of this nature, obviously the best means is to control the pollution of the water. If pollution were prevented, then the disease might be expected to disappear. It is seldom, however, that pollution can be entirely prevented. It has been stated that the disease occurs more commonly in streams, the waters of which are acid, than in those which are neutral or slightly alkaline. If this fact were established, control of the disease might be effected to some extent by controlling the acidity of the water. On a large scale the only practicable method of doing this is to increase the aeration of the water, so that its carbon dioxide is given up to the air, and the acidity of the water thereby reduced. Increased aeration can be produced by constructing weirs over which the water is made to flow in a turbulent fashion so as to expose as much surface to the air as possible. Another method of decreasing the acidity of the water would be to increase the hardness by allowing it to flow over or through a bed of limestone or chalk.

The Detection of Gas in Mines.

By T. C. Crawhall, M.Sc.

Science Museum, South Kensington.

The design of an ideal lamp for miners has occupied inventors since the eighteenth century. The principle of Davy's safety lamp has recently been incorporated in a new type, which combines electric illumination with the "flame" detection that was the basis of the pioneer discovery.

In recent years a number of circumstances has compelled the general public to take rather more interest than formerly in the work of the miner and the danger of his occupation has been more fully realized. It is known that in most coal mines, and in a few metalliferous mines, great danger is caused by the presence of fire-damp, and other inflammable gases, which, in the presence of a flame, will cause an explosion, the effect of which may be very serious. It is natural, therefore, that many able men should have devoted their energies to the prevention of these explosions by the invention of suitable lamps.

Fire-Damp.

The chief of the dangerous gases, fire-damp, is composed of a mixture of gases, the principal being methane, or "marsh-gas." This gas is highly explosive if brought into contact with a flame. Its weight is only about one half that of air, and, for this reason, it is found in greater quantity near the roof of workings than at the floor level, except when it is diffused owing to a rapid current of air. The gas is trapped in cavities in the coal and is liberated when the coal is worked. Usually this liberation takes place at a slow rate, but should a large cavity be tapped the result may very well be disastrous. Fortunately this is a comparatively rare occurrence. The gas held in this manner is at a high pressure, and a pressure as high as 460 pounds per square inch, more than thirty times that of the atmosphere, was recorded by Sir Lindsay Wood in his famous experiments. Fire-damp is not poisonous, and, provided that there is a sufficient supply of oxygen present, it will have no serious effect on a human being, always provided, of course, that it is not ignited.

Carbon monoxide, sometimes known as "white-damp," is another dangerous gas found in mines. It is a deadly poison, and is produced by the incomplete combustion of carbon, and frequently follows an explosion. It may also be due to spontaneous heating of coal or to small local fires. Fortunately, the miner generally knows of these occurrences, and is therefore unlikely to be caught unawares. If the presence of carbon monoxide is suspected, a bird, usually a canary, is taken into the workings. In the presence of a small quantity of the gas the canary will be overcome, and this is the signal for the men to retire, unless they are equipped with a portable breathing apparatus. The bird revives immediately it is taken into a pure atmosphere, and suffers no ill effects. Following an explosion, when carbon monoxide is almost certain to be present, a rescue party, equipped with breathing apparatus, will go into the workings, and the leader will take one of these birds with him. In order that the bird may be revived as soon as possible, Dr. J. S. Haldane has invented a special cage, to which is attached a small cylinder of oxygen. Apart from this method of testing, the gas is generally difficult to detect, and, for this reason, it is particularly dangerous. The first effect on a human being is a quickening of the pulse and deeper breathing, and the victim is so quickly overcome that he may collapse before he is able to reach a more pure atmosphere.

These two gases are the most important of the dangerous gases found in mines, although others, such as "black-damp," a mixture of carbon dioxide and nitrogen, and sulphuretted hydrogen are frequently found in varying quantities.

The Steel Mill.

The use of artificial illumination in mines makes it imperative that there should be some simple means of detecting the presence of fire-damp. In order to show the close relationship between the methods of illumination and the detection of inflammable gas it will be necessary to trace briefly the history of the development of the lighting appliances used.

Before the commencement of the nineteenth century the "steel mill" was the only means of providing a light which was moderately safe in "gassy" mines. Fig. 1 is an illustration of such an appliance. The illumination was provided by the sparks produced by a flint held against a rapidly rotating steel disc. Apart from the very poor light obtained, this apparatus

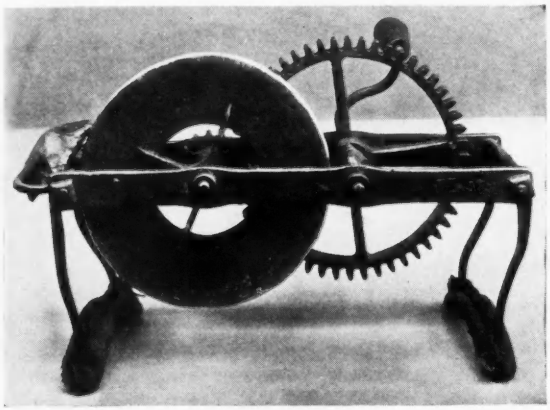


FIG. 1.
EIGHTEENTH CENTURY "STEEL MILL."
This pioneer safety appliance had the disadvantage of giving a very poor light and it required a boy to attend the miner to work it.

required a boy to operate it, and each hewer, or worker, was compelled to have this boy with him wherever he went. There is no doubt that in mines containing only a small percentage of inflammable gas the mill provided a moderate amount of safety, relying for this upon the low temperature of the sparks produced, and their small area. In "gassy" mines it was the cause of many serious accidents.

The very large number of explosions in the early part of the nineteenth century, with their attendant wide publicity, due to the increasing use of newspapers, had the good effect of producing serious investigation of the problem, and by the year 1815 Dr. Clanny, Sir Humphrey Davy, and George Stephenson had given the world the benefit of their research. The centenary of Sir Humphrey Davy has recently been celebrated, the most important function being held at Penzance, the town of his birth in 1778. He is well known as a scientist of great repute, and was a Fellow of the Royal Society. George Stephenson, on the other hand, was a working miner in Northumberland. His name is equally well remembered for his work in connexion with miners' lamps and with the early locomotives, particularly the "Rocket." Dr. Clanny, a medical practitioner of Sunderland, is not quite so well known, although he was experimenting with miners' lamps before both Stephenson and Davy. His early lamps were not a success, but later he was responsible for a very successful lamp which was similar in certain respects to the Davy Lamp.

It is supposed that Davy's attention was first drawn to the need of a safe lamp for use in mines by his visit to the Felling Colliery, in the County of Durham, after an explosion there on 25th May, 1812, in which ninety-two men lost their lives. A committee was formed in Sunderland, of which Dr. Clanny was a member, for the purpose of investigating the causes of accidents in mines, and Davy was invited to co-operate. Fig. 2 shows the two first Davy lamps actually used in a mine, which are now preserved in the Science Museum, with examples of other types illustrating the development of the safety-lamp.

It was found to be impossible to prevent the inflammable gases from reaching the flame, although attempts were made, chiefly by Dr. Clanny, to lead pure air from other parts of the mine, or from a container, but they were all without success. The invention of a lamp in which the flame was surrounded by a wire gauze was the solution of the problem. The inflammable gas which passes through the gauze causes the size of the flame to be increased, and the effect of the gauze is to dissipate the heat thus generated. Provided the quantity of the gas and the

FIG. 2.
SIR HUMPHREY DAVY'S INVENTION.
The first successful safety lamps actually used in a mine. The principle of the gauze which Sir Humphrey Davy introduced has been used ever since.

speed of the air current are not too great, an explosion will be prevented. To demonstrate the action of the gauze, a simple laboratory experiment can be conducted. If a piece of gauze is lowered over the flame of a bunsen burner, the flame may be extinguished without passing through the gauze. In a similar manner, if a piece of gauze is held about one inch above the top of the burner, the gas may be lighted above the gauze, but the flame will not pass below.

The principle of the modern flame type of lamp does not differ materially from that of the early lamps, and from these remarks it will be seen that this form of lamp acts not only as an illuminant, but as an instrument for safeguarding the miner. In the words of Sir Humphrey Davy " . . . the applications of this discovery (the gauze lamp) will not only preserve him (the miner) from the fire-damp, but enable him to apply it to use, and to destroy it at the same time that it gives him a useful light."

Some further explanation of this method of detecting gas by means of a lamp is necessary. In the presence of fire-damp a pale blue " cap " appears on the top of the flame of the ordinary miners' lamp, and the miner is constantly on the look-out for this cap. Not only is this a warning, but it may also be used as a measure of the quantity of gas present. In order to do this it is necessary to lower the flame until only a small portion of the yellow flame remains (about one-eighth of an inch), and then in the hands of an experienced person the quantity of fire-damp may be fairly accurately determined, within the range of one to five per cent, by observing the height of the blue cap. Less than from three to four per cent cannot be determined with a full flame. The height of the cap will vary with the type of lamp, the size of wick, and the kind of oil used, but as it is usual to employ only one type of lamp with a standard wick throughout a mine, the amount of skill required to estimate the quantity of fire-damp is considerably reduced. Gas testing is carried out systematically by specially trained men, known as " firemen," who are able to detect the smaller quantities, while the miner himself is able to detect anything above about three per cent. More than five and a half per cent of fire-damp in an atmosphere forms an explosive mixture, although as little as one half per cent may be dangerous in the presence of coal dust.

Some very useful research has recently been conducted on the estimation of fire-damp by flame caps by the Safety in Mines Research Board. In the introduction to their report (Paper No. 37) the following passage appears :—" Many methods for the estimation of fire-damp have been suggested, but none, as yet, approaches the ' flame-cap ' method for convenience and accuracy. Testing for gas, and estimation of the amount present, can be satisfactorily carried out with any well-designed flame safety-lamp. A lamp for illumination purposes is an essential part of every miner's equipment, so that the use of a flame safety-lamp for gas-testing does not add to the apparatus a miner is required to carry. The flame-lamp gives an automatic warning of the presence of fire-damp in dangerous quantity ; the manipulation required to obtain a close estimation of the quantity present, when the quantity is small, is not intricate ; and the indications are not masked by the presence of other mine gases, such as ' black-damp.' "

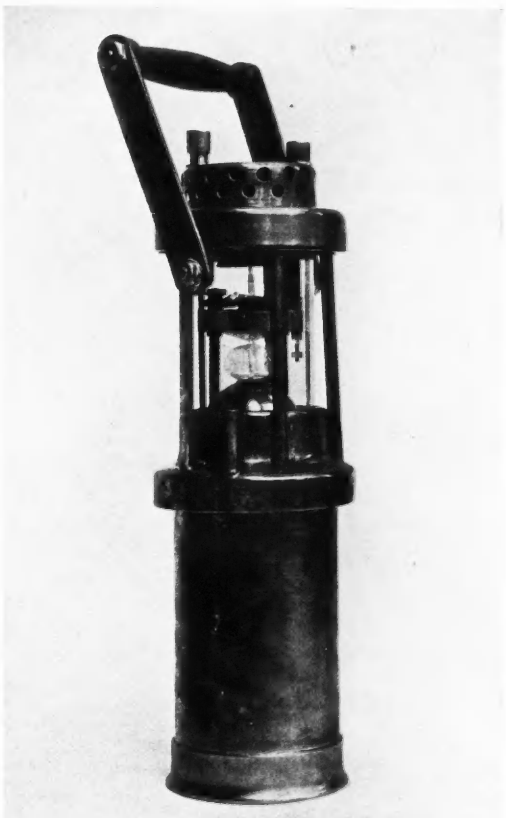


FIG. 3.
THE NEW SAFETY LAMP.
This combines the electric and flame type of lamps, giving the best illumination and a means of detecting dangerous gas in one compact apparatus. Working details are described in the text.

With the introduction of the electric hand lamp, the earliest of which was used in 1883, this very valuable feature of gas detection was lost, but, in spite of this, the number of electric lamps used in mines continues to increase. Their chief advantages over the flame

type are an increased power of illumination and a greater reliability. If it were not for the one great disadvantage that they will not indicate the presence of fire-damp there is no doubt that they would be universally employed.

The earliest lamps were fitted with primary batteries, and for this reason they were not a success. It was not until 1886, when Sir Joseph Swan invented a hand lamp which derived its current from a secondary battery, or accumulator as it is better known to-day, that the electric lamp was established for use in mines.

The natural development is obviously a combination of the electric and the flame types of lamps, which will give the best illumination, and which may be employed, at the same time, as an indicator of inflammable gas when this is suspected. There were many difficulties to be overcome, but such a lamp has now been placed on the market by Messrs. Ceag Ltd., of Barnsley. (See Fig. 3.) The current for the standard bulb is supplied by an accumulator, which is enclosed in the case of the lamp. Above the bulb is a small spirit lamp which may be lighted, when gas is suspected, by means of a coil of platinum wire fixed near the wick. The coil is connected to the accumulator, by which it can be heated sufficiently to light the wick. In order to test for gas the electric lamp is extinguished and the spirit lamp lighted. The percentage of fire-damp present may be estimated by means of the height of the cap on the flame, in the same manner as with the flame lamp. The spirit lamp has an advantage over the ordinary flame lamp, in which colza and paraffin oil are used, in that the height of the cap is greater for any given quantity of fire-damp.

In the lamp illustrated, the air necessary for combustion is obtained through the gauze in the top, which also prevents the passage of the flame to the outside atmosphere. The joints of the lamp must, of course, be gas-tight. The illuminating power of the electric lamp is not impaired by the spirit lamp, as the under surface of the spirit container acts as a reflector. A knob for adjusting the height of the flame and the switch for lighting the spirit lamp are conveniently situated on the top of the lamp, while the electric portion of the lamp is lighted or extinguished by holding the upper part firmly and rotating the lower case. To extinguish the flame after making a test it is only necessary to tilt the lamp.

Correspondence.

EMBRYOLOGY AND EVOLUTION.

To the Editor of DISCOVERY.

SIR,

Mr. de Beer, in a letter published in your July number, refers to a review of his book "Embryology and Evolution" which appeared in your issue of June, 1930. He also refers to a review of his book in the *Eugenics Review* published in April, 1930, which was also from my pen. The latter review I do not propose to discuss, as it is no concern of your readers, but I should like only to make two remarks about it. It was most improperly shown to Mr. de Beer before publication by the Editor of the *Eugenics Review*, who also printed an abusive letter by Mr. de Beer in reply to it *in the same issue*. I am in a position to state that effectual steps will be taken by the Council of the Eugenics Society, who control that publication, to prevent any such breach of journalistic etiquette on the part of the Editor in the future, and that a letter from me in answer to Mr. de Beer will appear in its next issue.

The answer to Mr. de Beer's conundrum is very easy, and the fundamental fallacy is his, not mine. He asks by what right I assume that when the young forms of a group conform to a type, and when this type is also shown by the young forms of its aberrant members I assume that the common ancestor showed that type in *adult* life. The answer is that the *type* of structure referred to is shown not only by the youthful forms of the vast majority of the members of the group, but is retained by them *all through life* until the completion of their growth and the attainment of the completely adult condition. When the aberrant members of a group show the typical structure in their younger stages and afterwards lose it, the sensible conclusion drawn by all comparative embryologists (except Mr. de Beer) is that their ancestors retained it throughout life.

Finally, I refer Mr. de Beer to the works of Eimer, who, as a result of a lifetime spent in the study of systematic zoology, arrived at the conclusion that new characters appear *at the end of growth* (*i.e.*, in the adult condition).

Yours truly,

43 Elm Park Gardens, S.W.10. E. W. MACBRIDE.

"UNWANTED ANIMALS."

To the Editor of DISCOVERY.

SIR,

I was very interested in the article on nature becoming unbalanced, in the last number of *Discovery* that reached me.

Owing to the destruction of the dingo and the provision of water in the arid districts, the kangaroos are a most serious trouble. To give an example: On a station where the owners are giving fourpence per head for kangaroos, and the skins are worth something besides, a paddock of about 16,000 acres (which would carry sheep at the rate of about one sheep to twenty acres), was raided by these animals. The kangaroos drank between 2,000 and 2,500 gallons from the trough, *i.e.*, presumption that there were at least 2,000 kangaroos in the paddock. All the other paddocks suffered the same. To you no doubt twenty acres to a sheep is very poor carrying capacity, but you must remember that in the pastoral districts the season is uncertain, and consequently one has to stock if not for the worst, for at any rate a poor season.

Yours truly,

Queen's Park, Western Australia. CLAUDE L. PIESSE.

The Problem of Pain in Animals.

By D. F. Fraser-Harris, M.D., D.Sc., F.R.S.E.

A comparison of the nervous system in human beings and animals suggests that there is the greatest amount of popular misconception about pain. The author shows how pity is often misplaced, whereas intense pain may be caused to animals by apparently harmless factors.

PAIN may be defined as a disagreeable kind of sensation which we instinctively desire to terminate. We distinguish bodily from mental pain, the pain of toothache from the pain of parting. Confining our attention first to human beings, we may say that all sensations have their seat in the brain, that if the grey matter of the brain is not in a state of activity, neither sensations nor pain can be perceived. Thus, while we are asleep or while the brain is under the influence of a drug, a so-called narcotic, we do not feel pain, because for the time being the grey matter of the brain is out of action. Shakespeare was quite right when he said: "He that sleeps feels not the toothache."

No Brain, No Pain.

Now just as we have no sensation in any part, say of the skin, if all the sensory nerves of that part have been severed, so neither can we have any pain. Hence in one form of leprosy, a disease in which the nerves of the fingers are destroyed, the patient feels no pain in these fingers. To perceive pain we must have at least a nerve and a specialized part of the brain related to it: no brain, no pain. It would therefore seem extremely probable that all those animals we call "invertebrate" which have no brains—jelly-fishes, worms, oysters, lobsters, etc.—feel no pain. We cannot dogmatize in the circumstances, but that would be the natural conclusion to come to.

Sensory nerves must have their origins somewhere—for instance, in the skin, or in the inside of a tooth—and we know that if the pulp of the tooth is exposed and some food or cold water has got into it, we shall suffer a certain amount of pain. In other words, the unusual, "unnatural," stimulation of the nerve-endings (really sensory nerve-origins) is a source of pain, but that pain will not be developed unless, in addition, a conductor (a nerve) is present and a brain-centre is also in activity. Physiologists divide pains first of all into two great classes, those due to the irritation of sensory nerves, and those due to the irritation of nerves of "pure" pain. Let us look for a little at the former of these.

When the ordinary sensory nerves, say in the skin, tooth, eye, or tongue are irritated or "stimulated" in some unusual manner, pain is the result. Thus the pain of a corn is in this first class, for the sharp core of the corn stabs a sensory nerve of the skin just as effectually as though a needle had been run into the nerve from outside. Here we have an ordinary nerve stimulated in an extraordinary manner. All tearing, bruising, compressing, etc., of the sensory nerves gives rise to pain, because these are all unusual, abnormal stimulations of the nerves, the result of which in consciousness is pain. A naked nerve is not intended to come into contact with the outer world; if it does, as in an exposed blister, the result is painful. Even a breath of air is painful to an open blister. Another variety of pain in the first species is pain due to the excessive stimulation of a sensory nerve. This is perhaps the commonest cause of pain. A warm drink is pleasant to swallow, but boiling water is excrutiatingly painful. A slight pressure on the skin is endurable, to have the nails squeezed in the thumbscrews is torture.

The Internal Organs.

The second great class of pains is that in which the irritation is applied to a nerve of "pure" pain. By this we mean a nerve whose exclusive function is to convey impulses of such a kind as give rise to pain. Fortunately some of these may rarely or never be in activity. The bodies of animals seem to be provided with nerves that normally give rise to no sensations at all, and which, therefore, may never come into activity once in a life-time, but which when stimulated produce only painful sensations. Most of the internal organs—heart, stomach, intestines, gall-bladder—possess such nerves. With them it is pain or nothing.

In perfect health we have no sensations from the heart, but when something has gone wrong with this organ, as in angina pectoris, the patient experiences the most terrible agony. Similarly, in the case of the eye, the iris has no nerves of ordinary sensation, we are not aware of its presence. But if the iris becomes inflamed (iritis), we then experience a very painful condition in the interior of the eye. Ordinary

sensations from the cornea or "window" of the eye-ball are very vague and feeble; we are not really aware of the presence of the cornea until a grain of sand gets between it and the eyelid, when we feel it distinctly painful. And so it is with all the internal organs; they have no nerves which inform us of their condition in perfect health; not to know we have a stomach is to have a perfect digestion. But as soon as we have an attack of indigestion, the nerves of "pure pain" in the stomach make us disagreeably aware that all is not well.

Abolishing Pain.

Mankind, however, is more interested in getting rid of pain than in analysing it. There is more than one way, because the path from the surface or from the interior of the body to the brain is relatively a long one. There are, in fact, four places where pain may be abolished—at the place of origin of the sensory nerve-fibres (periphery); in the nerve-trunk, in the spinal cord, and lastly in the brain itself. We abolish pain of peripheral origin when we paint cocaine over the tonsils before cutting them out, or freeze the gum before drawing a tooth. Here we are putting out of action the microscopically small beginnings of the sensory nerve. A frozen finger, nose or ear feels nothing because the sensory nerve-origins being frozen will not conduct impulses. They do not permit any impulses to be even started on their way to the brain, therefore the brain feels nothing because there is nothing to feel. This is alluded to as "local anaesthesia."

In the second place, one may interrupt the conduction in the nerve-trunk, as when the nerve is cut, pressed upon or frozen so as to destroy its conductivity. Pain-bearing impulses may also be interrupted in the spinal cord. This is what the surgeon accomplishes when he operates under "spinal anaesthesia." In this case he allows a drug to influence the spinal cord in such a way that, for the time being, the cord will not conduct impulses upwards or downwards. He then may cut out the appendix or amputate a leg without the patient perceiving any pain. Here there is no pain because the pain-bearing impulses, being blocked in the spinal cord, never reach the brain. Lastly, we can abolish pain by rendering the brain itself—the percipient centres—inactive. This is called "general anaesthesia" because when the brain is thus put to sleep artificially by chloroform, ether, nitrous oxide or other "anaesthetic," all sensations from the body are abolished. Chloroform not only makes human beings and animals insensitive to pain, it also blocks out these algesic impulses which are so injurious to the body and so prone to lower the sufferer's vitality or resistance.

It is physiologically proper that pain be prevented as much as possible, because it is certainly injurious to the body if at all long continued. In the case of persons tortured on the rack for example, such profound neural fatigue was induced that the victims often fell asleep sometime before they died.

We are now in a position to understand something about the nature of pain in the lower animals. The first fact that must be grasped is that reflex actions, reflex struggling, writhing, or convulsions are in themselves no evidence whatever that pain is being experienced. After an animal has been decapitated or had only its brain destroyed ("pithed"), its spinal cord is still capable of carrying out most powerful and complicated reflex actions, so that the now brainless "animal" may kick, jerk, writhe and even scream without a scintilla of consciousness being present. This is such a fundamental fact in neural physiology, that it must be grasped beyond all possible ambiguity. Not to understand it is to introduce endless confusion into the subject of animal pain.

Some Experiments.

The typical experiment is done on the cold-blooded frog, which can be instantly decapitated by a pair of scissors, and so leave the body and limbs in such a condition that they will live for many hours. The reason for this is that the heart continues to beat long after the head is removed. This headless "preparation" is absolutely destitute of sensation, emotion or volition. It can be hung from a hook, and will remain motionless until it dies by drying up. The spinal cord is alive but in the absence of the brain has no spontaneity, no sensation, and therefore no pain: no brain, no pain. If now, instead of allowing it to dry up, we keep it moist, we can discover some interesting capabilities of this "spinal frog."

If we touch a toe, the foot and leg of that side will be drawn up not by any act of will on the part of the brainless preparation, but by a purely muscular reflex action. This kind of reflex action, which is not accompanied by consciousness, is known as "excito-motor." If we place a piece of acidulated blotting paper on one flank, the corresponding leg will be drawn up and flick away the paper with a dexterity and precision worthy of the fullest consciousness. Further, if we hold down this leg, the *other* leg will eventually be brought up instead and flick away the paper. It *looks like* the most determined intention; it is nothing of the kind, for this spinal frog has no mentality whatever, and will hang from the hook

till it becomes a mummy. Similarly, a headless snake will wind itself round a red hot poker—no conscious animal would do that.

The " spinal " frog will originate nothing and never make an effort to get free. It is no longer " a frog," it is an amphibian reflex mechanism. A headless frog is not a dead frog, but only a living, reflex, spinal apparatus. It is a spinal cord still actuating an unconscious body. If we deliver to this headless trunk a series of rapid electric shocks, we shall throw the whole body and limbs into violent convulsions which are no sign of sensations or of pain. All decapitated animals are capable of movements which *look* extremely like those of conscious life, but are not. The decapitated hen or duck, which rushes round the farm-yard, has certainly, for the time being, life, but its muscular commotions are not the sign of conscious life. These decapitated birds having no brain, have no pain ; even the kitchen-maids know that amount of physiology.

The brain, however, may be present and yet may not be performing its functions, one of which is to perceive pain. It may, for instance, have become extremely anaemic (exsanguinated) as in the case of an animal whose throat has been cut. In the Jewish method of slaughtering an animal, all the four great blood-vessels in the neck are severed by one sweep of a long knife, so that the animal, rapidly losing much blood, becomes insensible and falls to the ground struggling. These struggles betoken no consciousness, no pain, they are indicative of no " death agony " however much they look like it, they are the last convulsions of muscles about to die. These muscles are in convulsions because the dying (but not dead) spinal cord is sending to them their last impulses. These convulsions are the last signs of life, but it is life without consciousness. There is *com*motion, but no *e*motion. The Jewish method of slaughter is, thus, a humane method, for in a second or two the exsanguinated brain is insensible.

Animal Injuries.

In themselves, then, writhing, wriggling, squirming and all these sorts of muscular spasms are no evidence of a suffering creature. On this subject there is the greatest possible amount of popular misconception.

Another factor affecting pain in the lower animals is richness of sensory nerve-supply. We have every reason to believe that, region for region, the nerve-supply (innervation) in the lower animals is not so abundant as it is in man. Thus the lower animals are able to get about with wounds and injuries of such a kind that similar ones in man would cause agony if not fainting. We ought not to interpret animals' discomforts in terms of human sensitiveness.

A dog will hop along on its three legs with the broken fourth leg dangling in a fashion which is not comparable with human behaviour. It is doubtless suffering to some degree, but to imagine that it is suffering to the extent of a man with a similar injury is to misinterpret the whole affair. A horse which has just fallen down and cut its knee will certainly stand trembling for some time after the accident, but only by the greatest stretch of the imagination can we maintain that it is suffering to the same extent as a man would do in similar circumstances. A fish that has had a hook in its gills, will return very shortly afterwards to the same hook. Animals caught in traps and snares—odious and cruel as these things are—struggle vehemently to be free, but once they are free, they do not seem to be very much disturbed by their wounds. After a little licking of the part, they resume their former mode of life as though nothing very serious had happened.

The Skin.

The next thing we should understand is that in the healthy animal, the *skin* is the tissue in which resides the maximum potentiality of pain. In simpler language, to cut, tear, pierce or crush the skin is very much more painful than to insult similarly any other healthy tissue. We must emphasize " healthy," because an inflamed internal organ can be exquisitely painful. For the moment, we are considering only the healthy normal animal. The reason for this difference between the pain-possessing powers of the skin and those of all other organs, consists in the much greater number of sensory nerves in the skin as compared with all other regions. The internal organs, in fact, possess no nerves of " ordinary " sensation in the sense that the skin does. But they do possess nerves of " pure " pain which, as we have seen, are not brought into activity unless and until the part becomes inflamed or diseased. This is a point not readily grasped by those who have not studied the subject of nerve-supply. In perfect health, it is obvious that the states of the internal organs are almost entirely outside our consciousness. The movements of the heart, of the intestines, of the gall-bladder, of the blood in the nerve-sheaths, etc., are, *in health*, entirely unperceived. The older way of putting this was to say that these internal organs had " vegetative life " which was sharply contrasted with the conscious life of the rest of the organism.

Consider the case of a healthy animal or human being in whom we have cut through the skin and are

handling the internal organs. Curious as it may seem, the handling of the healthy heart, stomach, intestine, liver or kidney not only arouses no pain, but is scarcely perceptible. Only very rarely nowadays can an observation of this kind be made because both animal and human being would, in these circumstances, be under the influence of an anaesthetic. But such observations have been made. The classical case is that related by the great William Harvey himself, how he took King Charles I to see a patient whose heart was (congenitally) exposed. Harvey tells us distinctly that unless the young man *saw* them touching his heart, he was completely unaware of it.

Any surgeon will assure us that the brain itself is insensitive to contact or cutting. Similarly, as regards the writhing intestines, they are always "writhing," which is only another word for the more technical "peristalsis." Those who misunderstand or misrepresent these things, assume that because the intestines are "writhing" they are *therefore* painful—there never was worse physiology. The intestines are "writhing" all the time, and although we do not see them they are moving "for all that" (painlessly). They still move painlessly when we open the abdomen and inspect them. A story used to be current in the Glasgow medical school that during an abdominal operation, the patient came out of the chloroform too soon and placidly watched the surgeon handling the coils of intestine. The exposure of an uninflamed organ is painless. It is the surface of the body—the skin—that is pre-eminently painful. As soon, however, as the internal organs are inflamed they do become extremely painful. The inflamed peritoneum, inflamed bone, inflamed nerve (sciatica) are all agonizing.

It is because the pain originates in the skin that we always anaesthetize an animal before cutting the skin. The puncture of an animal's skin by a hypodermic needle is a mere momentary inconvenience; many animals continue to eat unconcernedly while blood is being drawn off from their veins, because veins have no sensation.

Mental Pain.

When, on the other hand, we consider the *mental* side, we soon discover that this is the really distressing thing for a lower animal. A horse which is making very little fuss over its cut knees, will leap back in terror at some unfamiliar object. A dog enjoys fighting, and when once he has got his enemy's fangs out of his neck, he does not worry any more on that account; but he will bay in distress at the full moon as at some strange and sinister eye gazing fixedly at him. The dog which hops about unconcernedly with that broken leg, will howl with alarm at some sudden and unusual sight or sound.

The mind of an animal, like that of a child, is so limited that anything it has never seen before is strange to it, and anything which an animal cannot at once understand may throw it into a state of terror. It is the unknown and the unexpected that animals cannot abide. The dog surprised and alarmed will bite even his beloved master. Animals suddenly startled can be reduced to a condition of extreme agitation. The fear of the unknown, the unfamiliar, is enough to throw many animals into a state bordering on madness. The incomprehensible is to them the detestable. The sense of impending ill makes animals supremely uncomfortable and highly irritable. This statement is in perfect accord with that of Professor Dodds, that laboratory animals have no "apprehension." What he meant is that as the animals have no means of knowing what is in store for them, say an operation, they do not suffer that type of mental pain which the apprehensive human being suffers while waiting for an operation. A man knows that an ordeal is before him, the animal has no means of knowing anything of the kind. This is what Dr. Dodds very properly emphasized.

Cruelty of Hunting.

But once an animal is able to suspect that some harm is intended to it, if it is roughly seized or hunted by its natural enemies, then its agitation is extreme. The panic of the hunted hare, fox or stag is pitiable. I have often made my students observe how that if you merely catch hold of a rabbit and lay it down gently on its back, preparatory to giving it chloroform, it will scream in such a fashion that anyone not in the room, and therefore not seeing what was going on, would certainly conclude that the animal was being tortured.

We are, in brief, too apt to overlook or minimize the painful *mental* side of an animal's life. Animals can certainly suffer from mental anguish; they suffer as children suffer who cannot comprehend what is about to happen to them, for both animals and children dread the unfamiliar and mysterious. Animals can be disappointed as truly as human beings can, and they know when they are being cheated, frustrated, circumvented. Their powerlessness makes them afraid and irritable. Animals can suffer grief, inconsolable grief, ending in death by starvation. The story of "Greyfriar's Bobby" is no isolated myth; even a dog has been "faithful unto death."

The Habits of the Gannet.

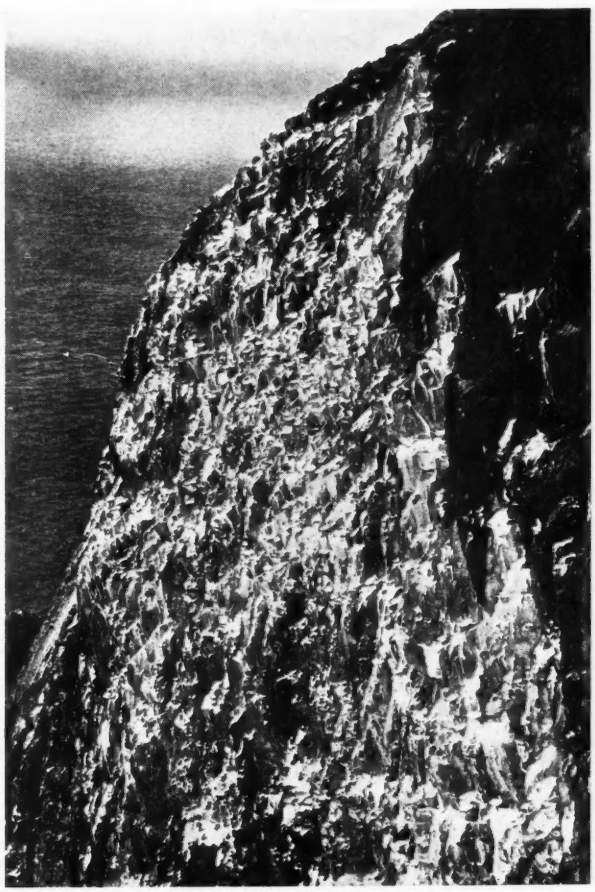
By M. G. S. Best.

The Gannet is one of the most picturesque of British sea birds, but little is known of its habits as it is seldom seen inland. Miss Best recently paid a visit to the island of Grasholm, which is inhabited by a large colony of Gannets, and here describes her observations.

THE Gannet, or Solon Goose (*Sula bassana*), with his snowy white plumage and his long black-tipped wings which boast a stretch of 5½ feet, is certainly one of the most notable of all our British sea-birds. It is a joy to watch him on a summer's day, flying slowly overhead, high above the water, intent upon his fishing. Suddenly he will pause in his flight, hang in the air for a brief second, then, with half-folded wings, hurl himself almost perpendicularly into the sea, disappearing from sight in a big splash of water.

Fishermen say the birds have been caught in nets sunk to a depth of 180 feet; their dive must have carried them to that depth, as they do not swim under water. When a fish has been caught, the gannet will generally sit on the water and swallow it at his leisure, but if he has missed his catch he soars upward again and continues fishing. The fishing seems to be a continuous performance whatever happens, only, when the dive has been successful, there is a slight pause before he begins again.

These great birds weigh as much as six pounds or more, and if they eat their own weight of fish in the day it would account for their untiring zeal.



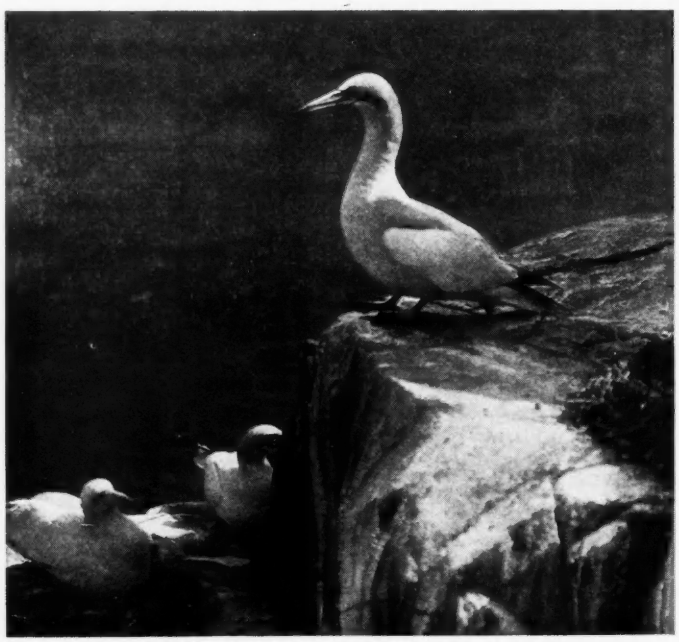
NESTING ON THE BASS ROCK.
On these narrow, wind-swept ledges thousands of gannets build their nests.

Unless one happens to be near a nesting place, the gannets are not often seen inland except when they have followed a shoal of fish. We have watched them in Scotland in summer time, when they have followed the fish inland for four or five miles from the sea, and have been fishing in a narrow sea-loch. The gannet seems to fly at such a height above the water, that one wonders how it can possibly see a fish at all from that distance, and that the fish are at a considerable depth is evident from the time the gannet takes to come to the surface again. There are nine nesting sites of the gannet in the British Isles. Two are in Ireland, one is in Wales, and the others in Scotland. Mr. J. H. Gurney, in his book on *The Gannet*, gives most interesting accounts of each of these sites and all the history and literature connected with them; it is to this book that I am indebted for the dates quoted.

Until about thirty years ago England could boast of one nesting site on Lundy Island, off the coast of Devon. The birds could never have been very numerous there, and they seem to have left altogether after 1903. Perhaps this colony went to swell that already established on Grasholm, an outlying rocky

island on the north side of the Bristol Channel off the Pembrokeshire coast. This rock stands right out in the tide-way sweeping up Cardigan Bay, and is an impossible place to land on unless the sea is in one of its most placid moods. When we paid a visit there in July the sea was like the proverbial mill-pond, after the turmoil of a tidal-wave the day before, which had made the leaving of the rock a truly terrifying experience for a party of visitors there.

All along the cliffs, and the slopes above them, on the north side of Grasholm, gannets were nesting—a thick mass of white birds from one end of the island to the other. The ground was covered thickly with nests — circular mounds built a foot or more in height, with a depression in the centre. Years of building must have been necessary to attain that height and substance. Seaweed formed the basis of the material, but it was all so thickly covered in a lime-like deposit that it was difficult to see what had been used. On arriving at the top of the rock, the birds nearest to us rose into the air to join the other half of the population which was sailing round and round over the sea in a wide circle, the rim of which just overlapped the edge of the cliff. As the birds were moulting their body feathers by that time, the air was full of down shed by the gannets as they rose into the air. It nearly choked us as it fell, and we breathed the feathers into our noses and down our throats.



A CLOSER VIEW OF THE BIRDS ON THE BASS ROCK.

In the open spaces between the nests were parties of young birds, gathered in groups like children at school. Most of these were in the downy stage, and they looked like enormous powder-puffs with black bills and faces. They waddled uncertainly about, helping themselves along with their wings, and stumbling helplessly over every obstacle they met. Some of the older ones were getting their first feathers, and as these dark feathers took the place of the down the youngsters became mottled and untidy in appearance, as large patches of the down remained on the body for some time before the growing feathers pushed it off.

These gannet nurseries have a curiously untidy and unfinished appearance : there seems to be no method about them. Even as late as July, when the colony had been fully established for over 2½ months, eggs and newly hatched young were found in many nests. If a visit is paid to the nesting grounds of gulls, terns or cormorants, there is an orderly sequence in their proceedings, and, although here and there a freshly laid clutch of eggs is seen, it is obviously the exception. Although in the case of the gannets some accident had probably overtaken the first eggs laid, still, the curious fact remained that there was such a large percentage of them.

Where the birds are nesting on narrow wind-swept ledges, as they do on the Bass Rock, it is interesting to notice the great care the parent birds take of their chick, one of them sitting patiently beside it all the day long until it is well advanced in age. On Grasholm, however, although there were nests on the ledges down the face of the cliffs, the greater part of the colony was comfortably settled on the slopes at the top of the rock whereon was plenty of room for the babies to stumble about at will. They shuffle along on the tarsus with their legs bent, not using the feet at all, which gives them a most awkward mode of progression. Their feet must merely be used as paddles when they swim, though some authorities state that the gannet has another use for them, which is to fold one foot over the other on the top of the egg before sitting on it. This theory may seem as questionable as the tale that the gannet glues its eggs on to the nest with its excreta to prevent their rolling over the edge, but

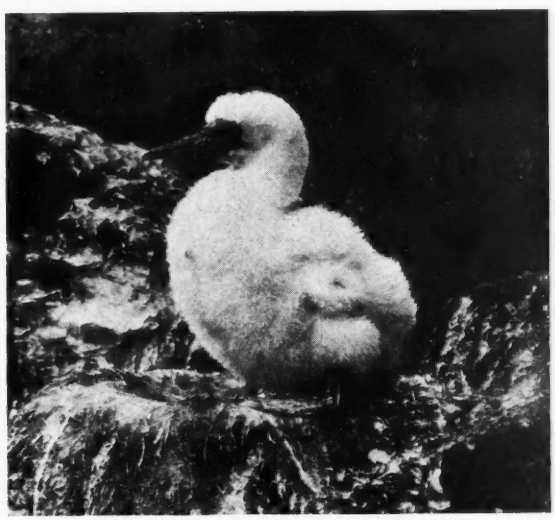
THE ADULT GANNET ON ITS NEST.

lately, a friend has told me that he has seen the South African gannets doing exactly the same thing.

Observations on the habits of these birds are not easy to make. They choose the most outlying rocks in the open sea for their nesting grounds, which seldom give opportunity for landing. At Ailsa Craig, as well as at the Bass Rock, there are lighthouses, and the men in charge of the lights are ready to give such information as they have collected, but the ordinary ornithologist, seeking first-hand knowledge, has to do the best he can in the short time allowed him ashore before he has to take his departure. One cannot protest when the boatman shows signs of anxiety about the "tides," but one could well do with more time allowed, especially as the birds are disturbed at first by seeing strangers, and have not returned to settle down again before one leaves. During the two and a half hours which we spent on Grasholm we saw no feeding operations whatever. That the young birds had been fed fairly recently was obvious from the fish they disgorged when alarmed. This habit of disgorging must be of frequent occurrence judging from the behaviour of their neighbours, the gulls. These birds were sitting about on the skyline at the top of the island, from which advantageous position they could overlook the whole gannets' breeding-ground. The instant a young gannet reproduced its dinner, the herring gulls came down to it with a rush and quickly demolished the fish. Such easy meals were worth waiting for!

Mr. J. H. Gurney gives some interesting facts concerning the former trade in gannets, and the use that was made of them, which show how valuable these birds were until the middle of last century. In 1661 they were sold in the Edinburgh market for 1s. 8d. ready plucked and trussed. The price then seems to have been at its highest, for it steadily fell, till in 1849 they only realized 9d. The old story of how Charles II remarked that there were just "two things he disliked in Scotland, the soldan goose and the Solemn League and Covenant," shows that even as late as his day they were served at the royal table. The chief value of the young birds was in their fat, which, when boiled down, found a ready sale for many purposes, chiefly medicinal. Their feathers were also valuable, but there was this drawback—that even if they were thoroughly baked in an oven it was impossible to remove completely the most unpleasant smell adhering to them.

In August the young birds were collected. By this time they are usually very fat, having been well fed by their parents, and unable to take any exercise. They are fed for about thirteen weeks after hatching, by which time they are really almost ready to fly, and for the week or more that follows, after their parents have ceased to feed them, they live by absorbing the fat they have accumulated. By the beginning of September, about ten weeks from the date of hatching, hunger makes them attempt to fly, and they leave their nesting ledges for the sea below. By that time the parent birds have given up all interest in their offspring, and the unfortunate youngsters have to fend for themselves. And very helpless they must feel, for they live all day and night upon the water, which must in itself be a great contrast to the solid dry rocks on which their babyhood was spent,



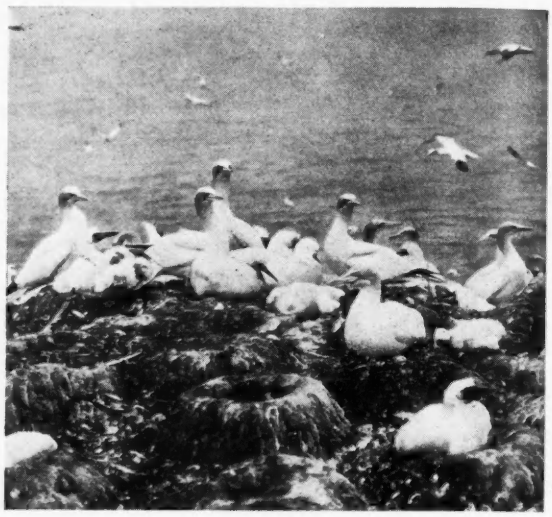
A YOUNG GANNET IN THE DOWNY STAGE.

and having to seek food which they have never seen in its native state before; moreover, the food must be caught, and that in itself takes some time to learn.

It is not to be wondered at, then, that the men whose business it was to catch the young gannets, knew they must be captured while being fed by their parents, for after that, they became so thin that they had no fat on them. Young gannets do not gain their full adult plumage for four or five years. Each succeeding moult introduces more white feathers on head, neck, and body, and gives the birds a very mottled or piebald appearance. Not until the full adult plumage is assumed does the gannet commence breeding. It seems reasonable to suppose that single-brooded birds, only laying one egg a year, must be a long-lived race, otherwise they would be in great danger of extermination. Mr. Gurney quotes one gannet, known by some malformation, which was known to have lived for eighty years. This seems a long life for a bird living the precarious existence of a sea-bird, contending, as it does, with wind and weather in its struggle for existence.

During mild weather in winter, gannets are seen fishing around these nesting grounds, although none land there until the nesting season comes round again. There is nothing to prove whence these birds come. On land, where it is easier to watch the movements of particular birds, the curlew, for instance, departs south to a warmer climate where food is easier to find, leaving our shores early in the autumn. Its place on foreshore and mudflat is taken by visitors from the north, and when spring comes round again,

A GANNET NURSERY ON GRASHOLM.



SOME ADULT BIRDS.

if one is fortunate, as once happened to the writer, a flock of these birds may be seen starting away from the coast where they had spent the winter across the North Sea to their summer quarters in Scandinavia. There is a big migration of gannets to the south in winter, the birds are found on the Moroccan shores, the Azores, and Canary Islands.

It would be hard to imagine any danger on land apart from man that would seriously threaten a gannet colony and disturb its peace, for these birds are quite able to take care of themselves, their bills being formidable weapons of offence. But a few years ago, a pathetic appeal was sent out from Ailsa Craig to the effect that the rats which had originally landed from a wreck, had increased to an alarming extent, and had raided the bird's nesting grounds, nearly exterminating the vast colonies of puffins, guillemots, gulls and gannets, and afterwards in their search for food, invading the houses of the inhabitants. The Royal Society for the Protection of Birds sent a consignment of rat poison there, and after a few week's careful work, the rock was declared almost free again. Later reports, however, tell of the increase in rats, and further steps are now necessary to reduce their numbers as far as possible.

The migration of the gannets is probably entirely regulated by the supply of food. Our British birds commence their departure during the latter days of autumn, and are possibly among those seen fishing off the Azores during the winter. These return to their rocks by the end of February, landing sometimes to inspect nesting sites, ready to begin building early in March.

Book Reviews.

Annual Report of the Empire Marketing Board, 1929-30. (H.M. Stationery Office. 1s.).

The Biological Control of Insect and Plant Pests. By W. R. THOMPSON, Ph.D., D.Sc. (H.M. Stationery Office. 1s.).

The chief concern of the Empire Marketing Board is to further the marketing of Empire products in the United Kingdom, and its work is mainly known in this connexion. An important and less well-known feature of the Board's activities, however, is its practical interest in the development of the biological and agricultural sciences, to which the greater part of the new report is devoted. A typical branch of this research is the extensive breeding of beneficial parasites, carried on at Farnham House Laboratory, which Dr. Thompson describes in detail.

The response of Dominion and Colonial entomologists has certainly proved that the laboratory meets a real need in Imperial entomology. Since its opening, the list of injurious insects and plants investigated has rapidly increased, and now comprises about sixty species. Investigations suggested by the Canadian Government are proceeding on the parasites of the pear slug, the codling moth, the wheat stem sawfly, the oriental peach moth, and the carrot rust fly, and in almost every case a great deal of valuable information has already been obtained. Four shipments, comprising in all more than ten thousand puparia of the sheep blowfly and cocoons of the pear slug, both of which contained parasites, were shipped to New South Wales in 1927 and 1928. Parasites were successfully reared from both these lots of material, and those from the blowfly have since been used for large scale breeding work in New South Wales. Shipments of other types of beneficial parasites have been sent to South Africa, New Zealand, India, Barbados, and the Falkland Islands.

Dr. Thompson's report is of particular interest as the first of its kind to be published. It is divided into four sections. In the first, the author outlines the principles and organization of work on biological control—the preliminary field survey, sample collections, the choice of beneficial species, large scale collections and shipments, the study of introduced parasites in the field, and the results of the experiments conducted. The other sections of the report describe the laboratory and review the practical work so far undertaken.

In the most common form of experiments, the beneficial insects attacking a noxious animal or plant are introduced into an environment in which they have never before been observed. The effectiveness of the introduced parasites or predators depends, however, not simply on the presence and abundance of the host insect, but on a precise and definite combination of the environmental factors. When a beneficial insect has been introduced into two different regions inhabited by the same pest, experiments have shown that the results may be very different. The introduction of a beneficial insect into a new country thus constitutes, in a certain sense, a new and unrepeatable experiment. Dr. Thompson points out that, for this reason, it is difficult to draw definite general conclusions from such work, which must be supplemented by theoretical considerations of the mathematical order, since the problem is mainly one of numbers.

The procedure is to begin with the more general facts of parasite and host interaction as it occurs in nature. These facts are then stated in mathematical language and from various aspects, so that all the deductions concerning the numerical relations involved in the hypothesis can be obtained, with much greater ease than by ordinary reasoning. The basic theory of operations on biological control rests on a few obvious facts. The potential reproductive rate of organisms is such that if all the offspring of every individual of any species survived in any generation, they would, in a relatively short time, occupy the entire area of the globe. But organisms do not increase uninterruptedly ; on the contrary, their populations often remain comparatively stable, or present oscillatory movements, of which the periods and amplitudes vary with different conditions. When a pest is transported into a new environment, without the normal enemies which habitually attack it in its native home, it naturally commences to increase and spread, provided that food material is available and that the physical factors are not more adverse. It therefore seems logical to introduce controlling factors whose intensity varies in proportion to the numbers of the pest, that is to say, the parasites and predators who attack it in its native home. The success of this introduction as a measure of control depends, in the first instance, on the effect which the new environment exerts upon the introduced species. It is therefore extremely important for the entomologist to follow the progress of the parasite carefully from year to year, so as to determine with certainty whether it is increasing or not.

One of the most important pests studied at Farnham is the codlin-moth, which is now found in almost every part of the world where apples are grown. Collections of hibernating the moth larvae and parasites were made in fifteen localities situated in nine of the principal apple-growing departments. The examination of the material is not yet completed, but up to the present eleven species of parasites have been obtained. It has proved difficult to collect sufficient numbers of codlin-moth in the field to provide really large colonies of the parasites, so it was decided to increase the number of parasites by intensive breeding methods. The results are likely to be of great importance to the future of the apple industry.

Science in Soviet Russia. By J. G. CROWTHER. (Williams and Norgate. 7s. 6d.).

The author has just returned from a month's tour of the scientific institutions in Leningrad and Moscow, and most of his observations are, he points out, reports of conversations with leading Russian scientists. The book is certainly interesting, dealing as it does with a little-known, though fascinating subject ; but it is difficult to escape the impression that, in a strenuous attempt at impartiality, Mr. Crowther is inclined to be a little biased in Russian favour. Conscious of the general unpopularity of the Soviet ideal, the author seems unduly anxious to show that, in scientific research at least, Russia is splendidly ahead of other countries, and certainly much improved as compared with conditions under the Tsarist regime. In doing so, he has given an impression of exaggerated sympathies which he may not have intended.

The author seems to have been impressed by the co-operation of science and industry in Russia. "The organic relations," he writes, "between the technical institutes, industry and the State are impressive. All three work together in a way which appears to contrast favourably with that in which the three interact in England. The three important activities seem to be conducted with excessive independence in England ; industry, technical education and the State sometimes rather jealously keeping too much to themselves, to their mutual disadvantage.

In Russia the position is different, and one feels that, opportunity for opportunity, the Russian system, which is an extreme form of the German and continental one, will achieve more. The scale and intensity of the organizing effort appear to me to be original."

Yet, earlier in the book, there is a curious contradiction of this desirable co-operation : " The Electro-Technical Institute at Leningrad has over two thousand students on its register, all of which have to pass a somewhat difficult entrance examination. For instance, if there are a hundred vacancies, there may be five hundred candidates. Of the five hundred, perhaps two hundred will pass the examination. A hundred of these are selected. Children of scientists have a specially good chance of being included in this selection, while those of commercial people have no chance, or only a poor one."

Whatever faults may be found with this book, no one will doubt the author's transparent sincerity.

Liberty. By EVERETT DEAN MARTIN. (New York : W. W. Norton & Co. $3.).

Dr. Martin is director of the People's Institute of New York, and is a master of the technique of adult education. His books on " The Behaviour of Crowds," " The Meaning of a Liberal Education," etc., have had a fair circulation among thoughtful readers in the United States, but this, although published in June of the present year, has immediately become one of the " best sellers." It touches so many sore spots that the people would have to be dull indeed if they did not sit up and take notice ; nevertheless, it is a comforting thought that they do. The book is written for Americans by one of them, it is the result of ripe scholarship and keen observation, and it is not flattering to the present age and generation. And yet, it is dangerous to shake the finger of scorn too hard at mob rule and the fear of the mob in America, for one may find on the very next page some uncomfortable observation that strikes home outside the United States.

Reading the book through, the conclusion, at least to the reviewer, is irresistible that the Crowd is Our Tyrant, to-day. Also that the crowd, swayed by propagandists, exhorters, and emotional rather than intellectual leaders, is wholly unmindful of freedom and despises the very thought of liberty as soon as it is aroused. This is the modern tyranny, and the problem is to wrest liberty from the mob without the alternative of another tyranny through dictatorship.

There is no short-cut to liberty proposed, for the only road seems to be the path of enlightenment. Let us make a few quotations that expound the present situation. " Any difference of opinion among men may be transformed into a ' moral issue.' Virtue has moved her residence. Once enthroned in the conscience of the individual, she now sits on the political platform." (The reviewer would like to suggest that when Virtue takes that place, she loses her character. Neither Socrates nor Plato was ever willing to define Virtue. But our American politicians and the leaders of a quasi ecclesiastical type, set up an Ersatz Virtue that is a malicious and dreadful harridan.) Martin goes on to say : " Very soon conscience will function only when the votes are counted. A new and sure method has been discovered for the redemption of mankind ; it is this : the way to make men good is to deprive all of them of moral responsibility."

Earlier in the work the ideas of liberty are associated with cultural traditions. The people who came to America before the revolution were largely English and Scotch non-conformists ; the great majority belonged to the lower middle class and the proletariat. They missed the liberalizing influences of the Renaissance, which explains much of puritanism. For generations the dominant American tradition and philosophy of life was Calvanistic rather than Humanistic. " When Calvinism declined it did not so much yield to a more critical, intellectually respectable, urbane and aesthetic philosophy as might have been expected ; it just slumped into literalistic bibliolatry, moralistic intolerance, Rousseauist humanitarianism, evangelistic enthusiasm, with scarcely any intellectual content whatever." This is severe, but it hits the mark in many places.

Later in the book the author declares : " History is full of the mischief such men have wrought whenever they have had the power. Their spirit of intolerance is very infectious, first because it is always disguised as zeal for righteousness, and secondly, because the crowd mind being, as I have shown, always potentially homicidal, once it is called into action, is very susceptible to the appeal of ' righteous indignation.' Intolerance begets intolerance both for and against itself. Now when there is a rapid spread of intolerance accompanied by . . . extension of the power of government and . . . a decline in the quality of statesmanship . . . there is every danger of an orgy of persecution. There are indications that the American people are setting the stage for just such a performance."

We could quote clear beyond the space available, but the foregoing may show the purpose of the book ; to awaken Americans and to point out that the greatest enemies of freedom and of liberty are not to be found among foreigners or in the designs of either political party, but rather in their own easy acceptance of popular slogans as shouted and followed by the crowd. The tyrant does not sit with crown and sceptre upon his throne in civilized countries any more. He is with us, nevertheless, as cruel and as vindictive as ever, in the voice of the mob. There abides the greatest danger to our cherished freedom and liberty, not only in America, but throughout the civilized world.

ELLWOOD HENDRICK.

The Technical Arts and Sciences of the Ancients. By ALBERT NEUBURGER. Translated by HENRY L. BROSE, M.A., D.Phil. (Methuen. 42*s*.).

It is a matter of common observation that the general run of scientific and technical textbooks, if they do not entirely ignore the historical aspect of their subject, rarely deal with it satisfactorily. All too frequently authors seem content to repeat what has been said by their predecessors, without endeavouring to ascertain if later research has proved it inaccurate or out of date. A work like Neuburger's " Die Technik des Altertums," now published in an English translation, meets a long felt want—to use a much overworked phrase. The amazing erudition of the author ranges widely over the technical achievement of the ancients. Not only does he cover such obvious subjects as the preparation and working of metal, wood, and leather, ceramics, spinning and weaving, the production of fire, habitations and transport, together with their subsidiary and concomitant arts ; he also explores such little-known topics as the preparation of soaps, fats, oils and perfumes, refrigerating and preserving, dyeing, and the technique of painting. The value of his work lies not merely in the text, it is much enhanced by the very full illustration of the appliances used, with reproductions from contemporary sources, paintings, sculpture-

and engravings from Egypt, Greece, Rome, and elsewhere. The pictures in the section on mechanics and machines may be noted in particular as excellent. They will give a valuable, and to many, an unexpected, gauge of the technical ability attained by the ancient engineer and mechanical expert. The greater part of the material is drawn from Egypt, Greece, and Rome, with references to India and very occasionally to primitive peoples for purposes of illustration.

It would have been an advantage if greater use had been made in some sections of the material made available by prehistoric archaeology outside the Mediterranean, and with which the author is mainly pre-occupied—for instance, in the sections on metallurgy, habitations, and agriculture. Reference might have been made to the use of the lamp in palaeolithic times. The wide range of subjects covered make this book one of the greatest interest to the general reader, while as a book of ready reference it should be in the library of every school and educational institution.

The Wilderness of Denali. By CHARLES SHELDON. (Scribners. 21*s*.).

If this book merely recounted the adventures of one of the most famous big game hunters of recent years, it would be well worth reading. But it does far more than that; it describes the habits of a variety of smaller and lesser known mammals, and therefore contains much of interest to the student of natural history. For the author was not only a prominent sportsman, he was also a distinguished naturalist. The late Charles Sheldon chose as his hunting grounds previously unexplored territory, and was thus able to return with valuable specimens. Incidentally, he was responsible for the discovery of many new species.

This book is an account of the explorer's expeditions in the wilderness surrounding Mt. McKinley, where the majority of his discoveries of natural life were made. The manuscript was prepared from the author's Alaskan journals, and is therefore in diary form. A diary always conveys an atmosphere which the more conventional "account" seldom achieves; the diary is written at the time of the incident described, amid the actual surroundings in which the author's experiences have taken place, and the account is far more vivid and real than a description compiled from an arm-chair sometimes months and years after the events.

Much of Mr. Sheldon's book might well be quoted at length were space to permit. His observations of the habits of the wolverine are particularly interesting. The explorer was fortunate enough to capture a female specimen, which he chained in a small log house constructed for the purpose. "The reputation of the wolverine for robbing caches and the baits of traps, and even for eating fur animals caught in traps, is well deserved," he wrote. "It persists in these habits and, because of its great strength, does considerable damage to caches and deadfalls. Wolverine have been known to carry off animals caught in traps, with the traps attached, but many descriptions of these habits are not limited to exploits among traps, but include tales of thieving, malicious destruction of property, the soiling of food and even the carrying off of empty traps. Reliable proof of such statements is not forthcoming and, in view of my own observations and inquiries in the north, I am inclined to regard them as products of the imagination."

Mr. Sheldon had also a unique opportunity of studying the habits of the Alaska-Canada jay. "Early in August two or three of the birds appeared and, when fresh meat was brought in, others kept coming until nine in all remained about the camp. They became more and more familiar until, in about three weeks, some of them would alight on my hand and grasp the meat held in my fingers. When I repeated a short whistle they would all fly towards me and alight upon my head, shoulders and hands, and would quarrel while picking the food. When I was left alone in the camp, the jays became still more friendly and seemed to adjust their mode of living to one which depended almost entirely upon me. They were persistently dominated by one insatiable passion, that of storing food. Should meat, doe, or any cooked food except fruit be placed in a spot accessible to them, they would at once begin to peck off pieces and store them in branches, crotches or pieces of bark, returning immediately to repeat the operation. Like ants, they would continue to do this during the whole of the day until all the food was cached.

"The food was stored carelessly, particularly when a large quantity stimulated their activities, in which case they stored blindly and immediately forgot where they had put it. Many times they were seen searching for the storing places. Seldom did they stop to eat any of the food offered them."

The book contains over one hundred photographs and a map showing the neighbourhood surrounding Mt. McKinley. Appendices enumerate the birds of the Upper Toklat region, the mammals of the Alaska range, new species of mammals discovered by the author in Alaska and elsewhere, skins and skulls collected and presented to the United States National Museum, the localities in which Charles Sheldon hunted, and a list of the tribes and bands mentioned in his diary.

George Eastman. By CARL W. ACKERMAN. With a Foreword by LORD RIDDELL. (Constable. 24*s*.).

A large part of this book is naturally devoted to the history of photography, and particularly to the story of the Kodak film and camera. In the earlier chapters the author deals not only with Eastman's early inventions, but also with the discoveries of his contemporaries. The later part of the book is mainly biographical, and reviews the inventor's wide philanthropic activities and particularly his interest in education. Since Eastman is chiefly known, at least outside America, as the parent of the Kodak, the early chapters are likely to prove most interesting. The story of his ancestry and youth might, perhaps, have been more briefly told, and in this chapter, particularly, Mr. Ackerman displays the biographer's most irritating offence—a passion for details which are neither remarkable nor particularly pertinent.

Eastman's early accounts, which he kept meticulously, show a practical interest in photography as early as 1869, and three years later it is recorded that he spent £20 on lenses and other photographic equipment. In the same year he arranged to take lessons from a local photographer. But photography remained a hobby until 1877, when Eastman first realized the possibilities of commercial production. It is interesting to recall that his inspiration first came from this country, for it was an article in the *British Journal of Photography* that "started him in the right direction." The article, which gave the formula for making a sensitive gelatine emulsion, led Eastman to compose a solution which could be coated and dried on a glass plate while retaining its properties long enough to be used in the field. Thus the necessity for carrying a dark tent and silver bath were eliminated. A refusal of financial assistance from a wealthy uncle was the first of many difficult obstacles, but Eastman withdrew his own

savings from the bank, increased his purchases of photographic materials, and by 1879 was not only making plates which were "entirely successful," but had invented an apparatus for coating them.

In 1884 the inventor produced his first film. The process of making transparent film was first conceived by coating a support with a solution of nitro-cellulose, then coating it with emulsion, and afterwards stripping it off. Both paper and glass were employed as a temporary support. The solution was composed of soluable gun cotton dissolved in concentrated sulphuric ether, and an equal part of grain alcohol, with ten grains of cotton to an ounce of solvent. A small quantity of castor oil was added to give the solution more body. The glass was first coated with this solution and allowed to dry. A coating of rubber and benzine was then applied. Ten successive coatings of nitro-cellulose solution were applied to the glass. Experiments were also made using paper as a support, and films were produced upon which it was possible to make pictures by leaving the films upon the paper support during the exposure and development, and stripping them afterwards. Thus the first practical film in the history of photography was discovered.

If Mr. Ackerman's book has a fault it is the abundance of footnotes, many of which occupy half of the page. But the whole story is an inspiring record.

Egyptian Sculpture. By MARGARET ALICE MURRAY. With a Preface by PROFESSOR ERNEST GARDNER. (Duckworth. 15s.).

Egyptian sculpture, and indeed Egyptian art generally, has certain essential qualities which mark it off from the fine arts of any other nation or race in history. As Professor Gardner points out in his preface, no other art of any one people can be studied in its development over a longer period of time. Notwithstanding the immense interval between its beginnings and its close, when it became decadent and finally disappeared under the weight of outside influence, it never lost its essential characters. The earliest and the latest examples in date equally bear the unmistakable stamp of their Egyptian origin. As Miss Murray reminds her readers, the peculiar characters of Egyptian sculpture were the product of a combination of certain factors which can be analysed with singular directness. The Nile landscape with its sharp outlines and absence of rounded contours, the architectural use of sculptured figures, and in the vast majority of cases the ceremonial character of the representation, were the essential elements. Yet notwithstanding the forces which make for a certain rigidity and conventionalism, Egyptian sculpture has an attraction which, as it were, irradiates through its majesty and force. Many examples, of which the limestone head of Nefertiti now in Berlin is the most conspicuous, have great charm. Yet even in the period of Akhenaten, when the artistic and religious ideals of that reforming monarch allowed play to realism and an exact portraiture, the sculptured figure never descends from a high level of dignity. Even at other periods convention and ritual idealism did not entirely obscure individual character. In fact, one of the attractions of a study of Egyptian sculpture is the appreciation of the character of its subjects through the ages.

Miss Murray's acquaintance with her subject is intimate and has guided her well in the selection of her very full illustration of this branch of Egyptian art. Her comments on each example, without being too detailed, give the reader the main points requisite for its appreciation. The notes on technique will help to an understanding of the measure of success which the Egyptian artist attained in solving the problems imposed by the conditions of material and the purpose of the artistic product.

The Letters of Two Fishermen. By HUGH COPLEY. (Frederick Warne. 6s.).

This book contains imaginary correspondence between two fishing enthusiasts, one living in West Africa and the other in Birmingham. In a preface, the author warns his readers that ideas are put forward which "are, perhaps, against the teachings of the classical masters of the art, but it can at least be claimed that they have all been tried out in practice on many waters. The possibilities of the West Coast of Africa from a sea fishing point of view are, even to this day, practically unknown and unexplored, yet there are many places on the coast which would yield magnificent sport to anyone trolling with a dead bait or a six-inch Wilson spoon. This last bait is not as well known to British anglers as it should be."

The chief interest of the book for those who are not fishing enthusiasts lies in the glimpses afforded of the ingenious methods of negro fishermen, which, it will be recalled, were described in *Discovery* last year. But the angler's best known characteristic is prominent in the letters of the West African correspondent, and his own prowess with the line is dwelt upon in more detail than the activities of the native fishermen.

Mr. Copley's book makes no pretence of literary merit. The letters are written in chatty vein, with a strong flavour of the slang which is reputed to be an important part of the true sportsman's vocabulary. Anglers will doubtless discover many useful hints, and certainly anyone who happens to be sojourning in West Africa and is equipped with a "dead bait or a six-inch Wilson spoon" will find Mr. Copley's book an invaluable work of reference.

Pythons and Their Ways. By F. W. FITZSIMONS. (Harrap & Co. 7s. 6d.).

This is a charming book, written by one who has not only studied his subject, but who has also the gift of writing so as to make the reader feel that he is actually witnessing the incidents described.

The only criticism we can make is with regard to the first sentence of the first chapter. Most of us zoologists are brought up to believe that the pythons are the Old World group and the boas the New World group of the "constricting snakes," and it comes rather as a shock to read that "Pythons are to be found nearly everywhere in the world where the sun is sufficiently warm for their comfort: in South-eastern Europe, Central and South Asia, Africa, Australasia, South and Central America, Western North America, and the West Indies" (p. 11). This is, I feel, a misuse of the term "python," and, in the appendix, the author himself divides the Order Ophidia into "Pythons (subfamily Pythoninae)" and "Boas (subfamily Boinae)."

The author does not deal with the boas, the whole book being concerned with the true pythons. Chapter I is mainly about their habits, and almost all the rest of the book, although incidentally referring to habits, consists of experiences with these large snakes—experiences of his own, and in one case of his courageous wife, which make cold shivers run down the reader's spine. We have not come across many "animal" books so enthralling as this one, which we read in two sittings having difficulty in putting down the book.

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